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Special **U. S. NAVAL AVIATION** Issue

FLYING
AND POPULAR AVIATION

VOLUME XXX
NUMBER 1

JANUARY, 1942

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ZIFF-DAVIS PUBLISHING COMPANY
Editorial Office: 540 N. Michigan Ave., Chicago, Ill.

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FLYING AND POPULAR AVIATION is published monthly by Ziff-Davis Publishing Company at 540 N. Michigan Ave., Chicago, Ill. William B. Ziff, Publisher; B. G. Davis, Editor; Max Karant, M.I.Ae.S., Managing Editor; George Berner, Advertising Manager; Herman R. Bollin, Art Director; H. G. Strong, Circulation Manager. New York Advertising Office, 270 Madison Ave. West Coast Advertising Representative, William L. Pinney, 416 W. Eighth St., Los Angeles, Cal. SUBSCRIPTION RATES: In U. S., $2.50 per year, single copies 25 cents; in Canada, $3.00 per year, single copies 30 cents. Other foreign subscriptions $3.50 per year. Subscribers should allow two weeks for change of address. Address all subscription letters to the Director of Circulation, 540 N. Michigan Ave., Chicago. Entered as second class matter, July 16, 1940, at the Post Office, Chicago, Illinois, under the act of March 3, 1879. Contributors should retain copy of contributions. All submitted material must contain return postage. Contributions will be handled with reasonable care, but this magazine assumes no responsibility for their safety. Accepted material is subject to whatever adaptations and revisions are necessary to meet requirements. Payment will be made at our current rates upon acceptance and, unless otherwise specified by the contributor, all photographs and drawings will be considered as part of the manuscript in making payment.

FOR THE DEFENSE OF YOUR FUTURE

The popgun makes a fine racket, but if your life were at stake, you'd never hesitate in selecting the powerful, accurate, deadly machine gun .... and YOUR LIFE IS AT STAKE when you select the training to prepare yourself for a career in aviation. The national emergency has enabled thousands of men to "hit" the aviation industry for temporary, single-phase jobs with the popgun of cheap "quickie" courses. BUT — Aviation's leaders will entrust responsible supervisory positions only to men with the "firepower" to reach and hit any target placed before them. The executives who have made aviation THEIR career know that the value of each man is governed by two factors: his serious purpose in selecting aviation as his life-work, and the ability and experience of those who train him for that career. They know that Curtiss-Wright Technical Institute graduates are — and for many years have been — thoroughly qualified to fill the industry's most exacting requirements.

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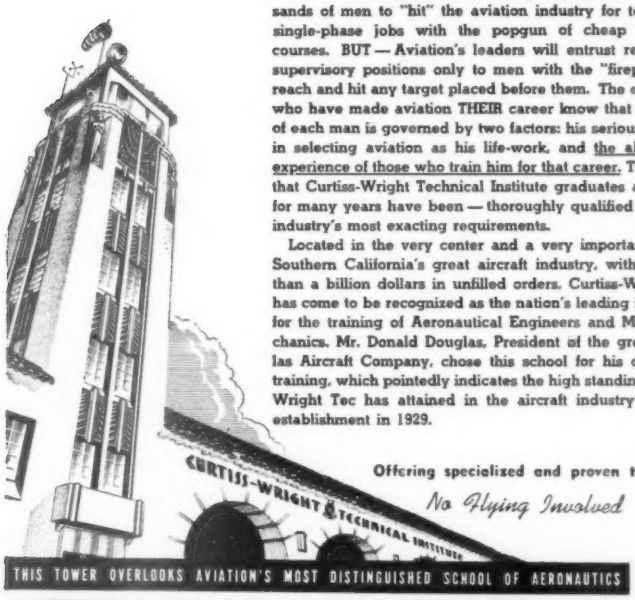

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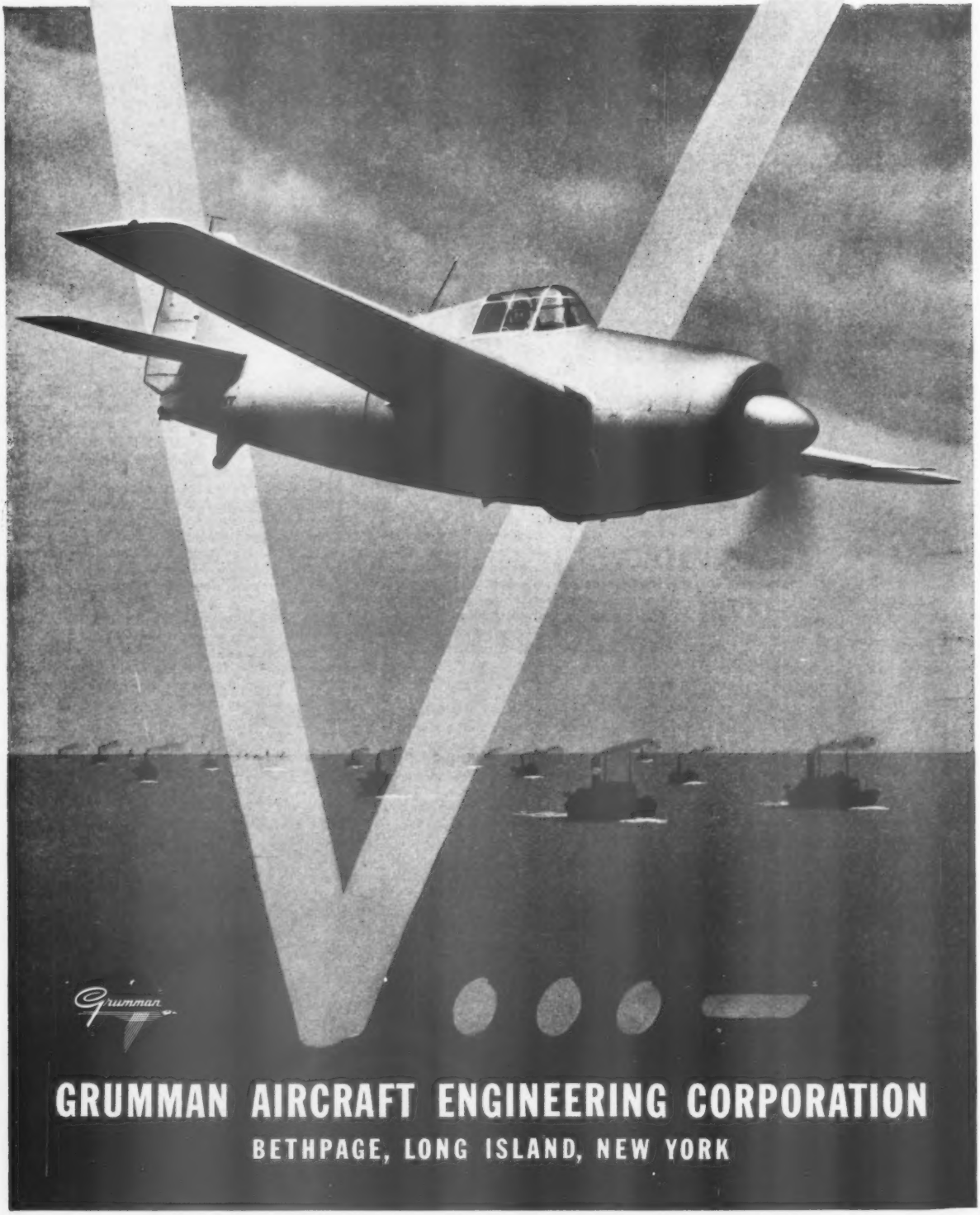

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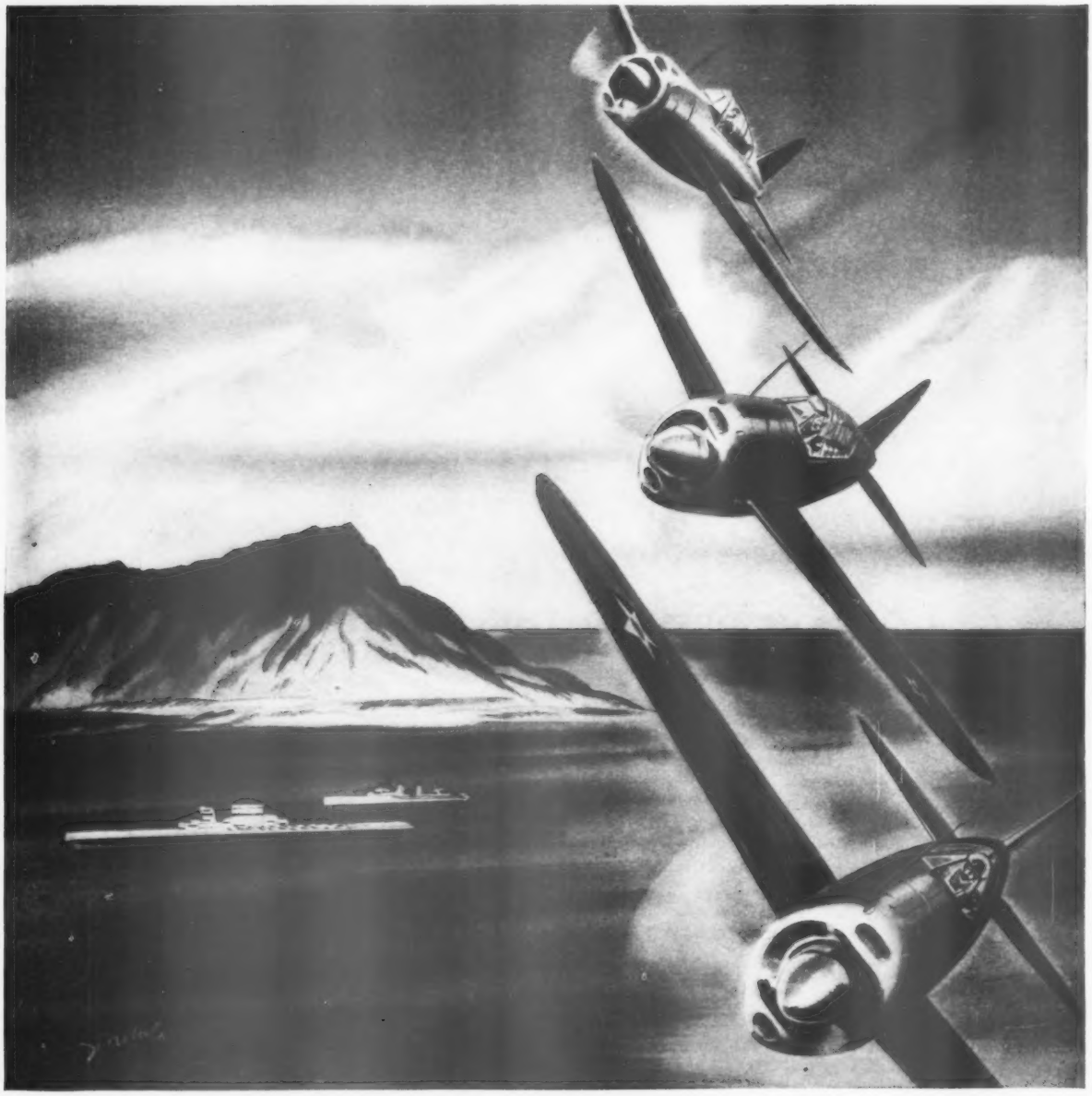

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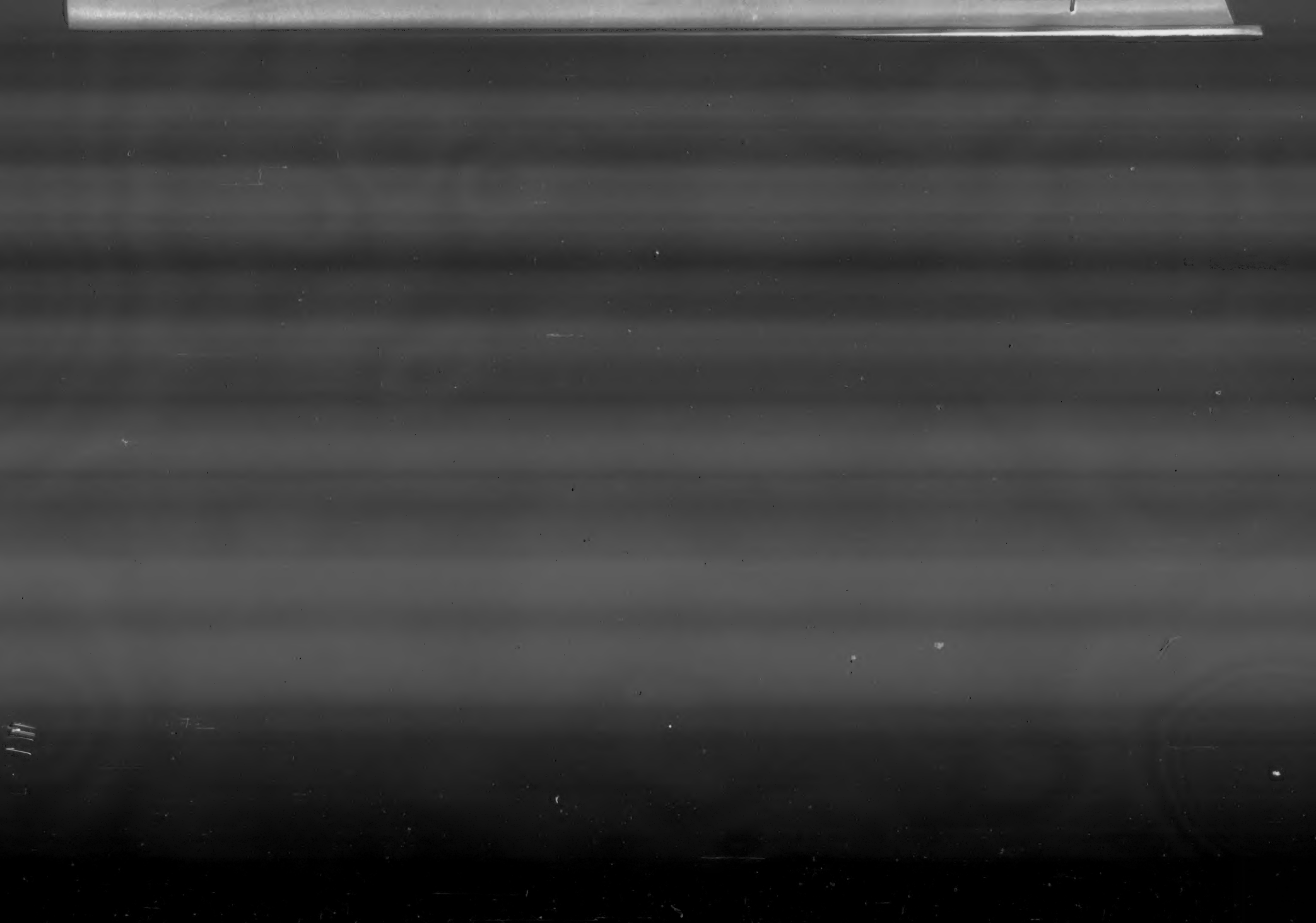

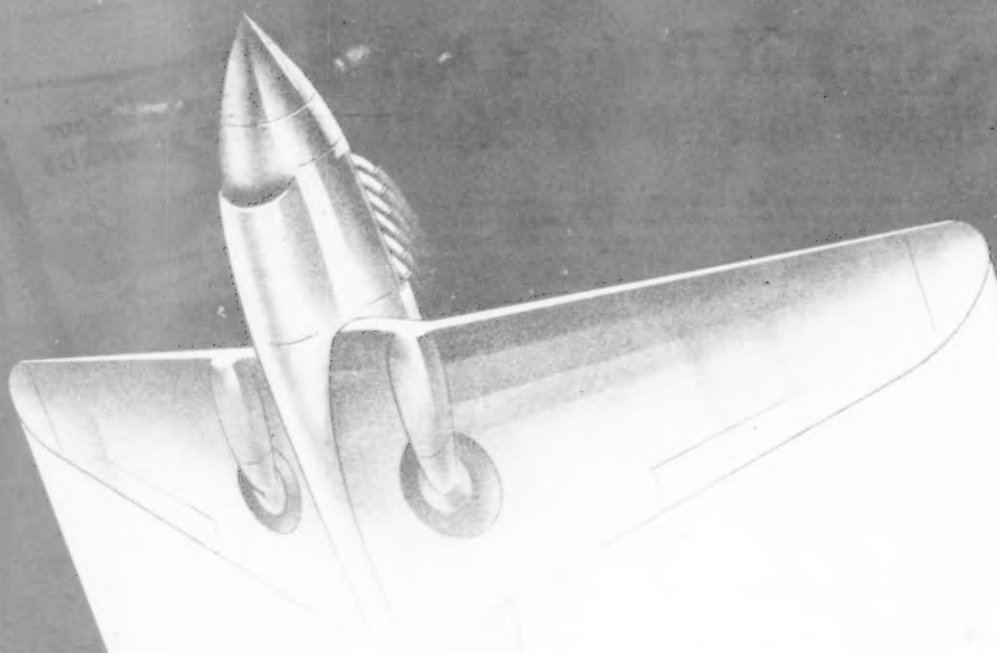

In order to give maximum assistance to the national defense program, and for the duration of the present emergency, Cal-Aero Flight Academy, Mira Loma Flight Academy and Polaris Flight Academy will continue to devote their entire efforts and modern airport-academy bases at Ontario, Oxnard, Lancaster and Glendale, California, exclusively to the training of Flying Cadets for the U.S. Army Air Force and Royal Air Force.

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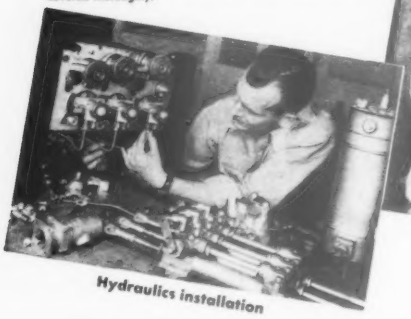

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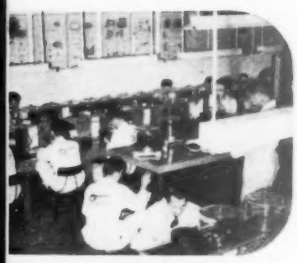

(Above) Instrument Department has $45,000 worth of newest equipment.

★ Down through the years since its inception in 1928 SPARTAN has kept in step with aviation progress. As this great American industry has rapidly advanced to its present dominant position, SPARTAN has also advanced in its training facilities and aviation courses. Today SPARTAN is recognized as one of the country's most modern and progressive aviation schools.

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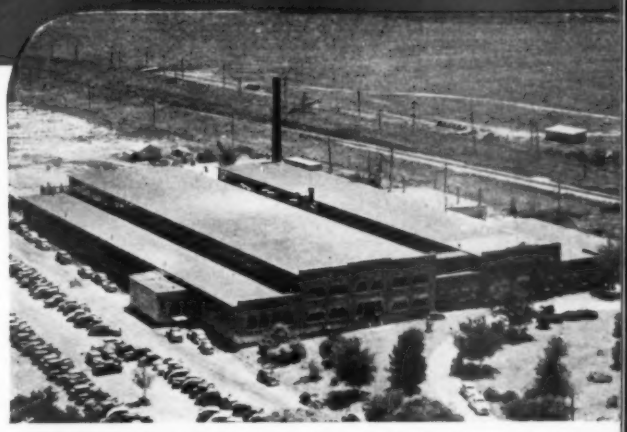

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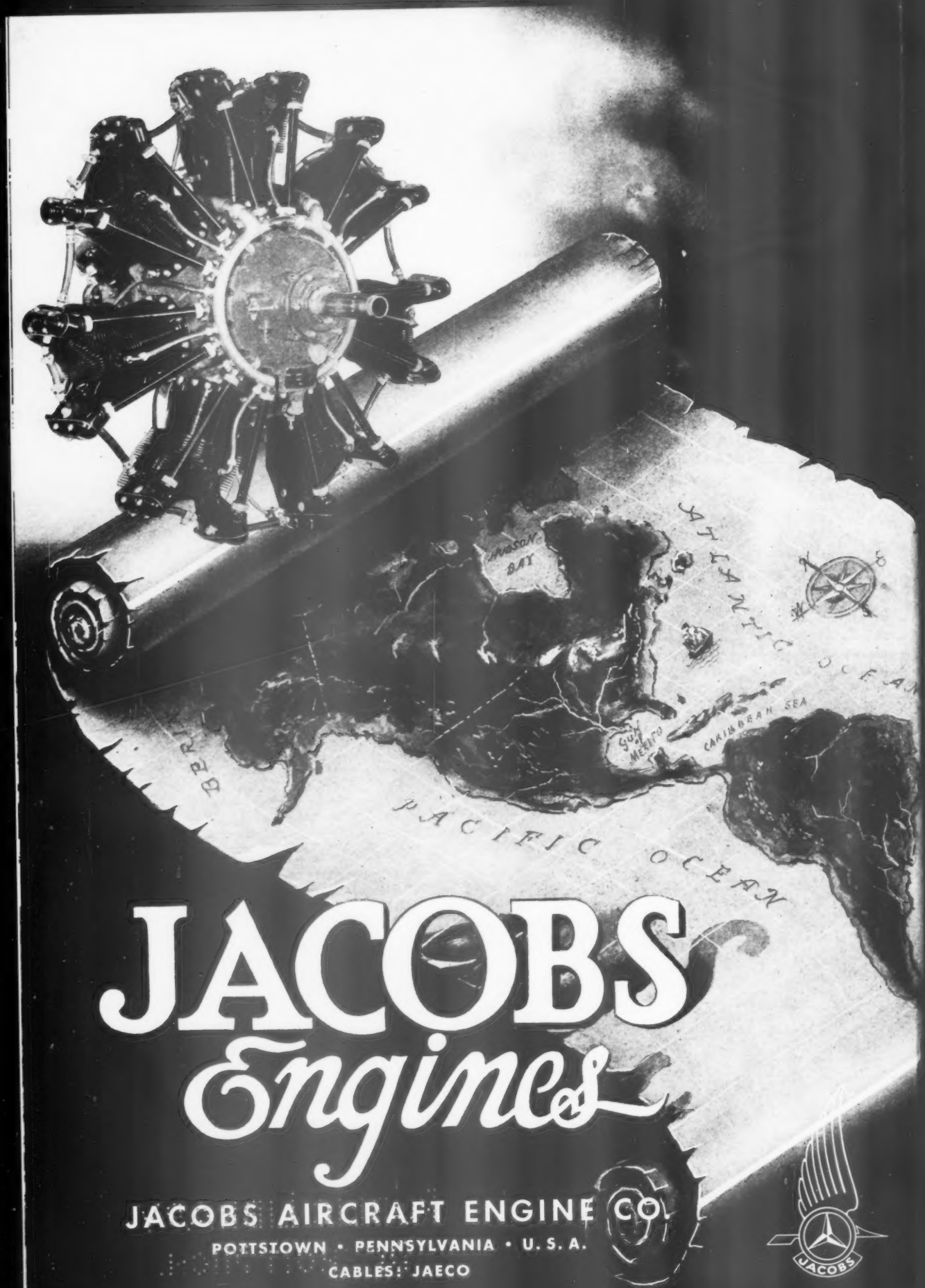

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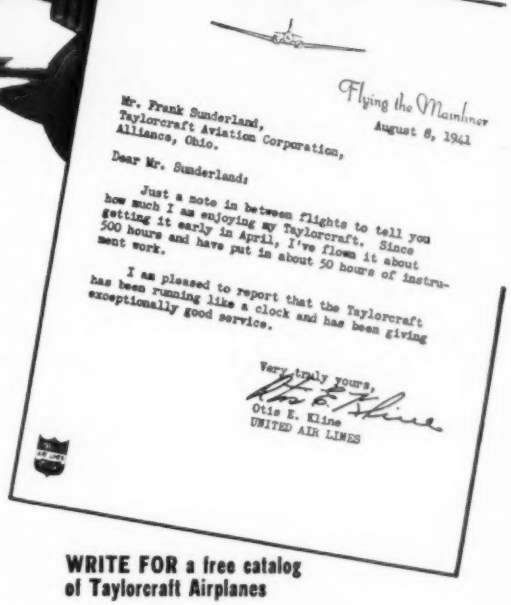

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You have heightened your son's chance for a successful future by giving him the understanding and encouragement he needs. But you can do more to further his ambition. You can help him select the best place for his training.

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The Dallas Aviation School was established in 1926. It is certified by the United States Civil Aeronautics Administration; is recognized by leaders in the aviation industry and is located in a state whose climate is favorable to flying the year around. It is the school we hope your son will select for his training.

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Foreword...

We are honored to present in this special issue of FLYING and Popular Aviation a critical study of one of the most important elements of our National Defense, the Air Arm of the United States Navy.

We do so believing that a great need exists for such a work. In these troubled times a secure knowledge of the structure and functions of our Naval Air Services is indispensable to all whose activities bear on the defense effort. To every American, whatever part he may play in the national endeavor, it must be a source of pride and assurance.

These sleek grey planes which keep the watch over the great turbulent wastes of ocean, are the bloodhounds of the Fleet. They are the first to the attack; they raise the alarm when danger threatens; they are the eyes, ears and mobile artillery of our first line of defense, the Navy.

Behind the smooth operations of this powerful air armada lie meticulous organization, long training and discipline, a working mechanism of many interlocking parts. Behind it, too, is something less tangible though not less real: the tradition of American sea power, to which these men of the air are now adding a luster peculiarly their own.

It is impossible in a study of this sort to present any of the more glamorous elements of character which so distinguished it, the color, knightliness and warm human relationships. These things regrettably, must be left to other and less technical accounts.

Many months of patient, painstaking effort have gone into the preparation of this issue. It constitutes we believe, the first complete and authoritative statement of the working mechanics of our sea-based air power. Its publication has been made possible through the generous and wholehearted co-operation of the Bureau of Aeronautics and its associate bureaus of the U. S. Navy Department, to which we make grateful acknowledgment.

William B. Ziff

Publisher, FLYING and Popular Aviation

AVIATION and the NAVY

by

Col. FRANK KNOX

Secretary of the Navy

A newspaper man since 1898, Colonel Knox became Secretary of the Navy July 11, 1940. Born in Boston in 1874, he served with Teddy Roosevelt's Rough Riders in Cuba, was a distinguished officer in the World War. A colonel in the Field Artillery Reserve since 1937, he was publisher of the *Chicago Daily News* when named Secretary of the Navy.

☆

THE rapidly increasing importance of aviation in Naval warfare is reflected in the successive increases in the Navy's aviation program. From an authorized strength of 3,000 airplanes in July, 1938, the Navy Department has sought, and the Congress granted, increases; in June, 1940, to 10,000, and in July, 1940, to 15,000 aircraft. These were not haphazard guesses as to what our air strength at any given date should be, but were carefully weighed estimates of the requirements of our expanding Navy, for Naval aviation is primarily seagoing, and bears an almost constant ratio to Naval surface tonnage. The projected "two-ocean" Navy will be a balanced force of ships and aircraft, and our advanced bases in the Atlantic and Pacific, on completion, will each have its complement of vitally necessary aircraft for scouting, attack and defense.

The United States was fortunate in having as nucleus for expansion a Naval air arm without an equal among the other navies of the world; the product of its own Naval officers and the American aviation industry. The aircraft it produced and their employment at sea set standards which the other maritime nations were content to follow, as representing the best in thought and practice. The aircraft carrier was developed to an efficiency of operation not yet attained abroad, even under the pressure of war. The airplane catapult, which permits the launching of aircraft from battleships and cruisers, was conceived and brought to everyday accustomed use by our own Naval aviators, and the long-range patrol bomber, which figured so prominently in the relentless chase and destruction of the *Bismarck*, is peculiarly American in design and production. Though wanting in numbers we had a firm foundation on which to build, with excellent prototype designs ready for mass production; with wide experience in the co-ordinated employment of aircraft in the Fleet, and with a devoted personnel, trained in their profession as Naval officers and enjoying the confidence and support of their brothers in the Navy afloat. Problems of design and of employment had been met and solved in the light of a common understanding of the Navy's needs and all of the agencies of the Navy Department had a share in the forging and welding of a Naval air force perfectly adapted to its role in Naval warfare.

With this well-tried organization as a pattern and a base, we are engaged now in a tenfold expansion. The lessons from the conflict abroad are being studied and applied; tried and proved designs are in quantity production; and four large training centers are turning out increasing numbers of pilots to man the airplanes which are taking form in a score of factories. Already there are more than 4,000 Naval airplanes in service; next July will see that number almost doubled, and the rate of increase is a steadily rising curve.

The Navy has never underestimated the importance of aviation in sea warfare and has found ample confirmation of its views in the events of the past two years. The lessons of Norway, Taranto, Cape Matapan and Crete demonstrated, if

(*Continued on page* 220)

OUR RESPONSIBILITY

by

ARTEMUS L. GATES

Assistant Secretary of the Navy for Air

Third to hold the office since its inception in 1926, Mr. Gates is veteran of World War I Naval aviation. Born in Cedar Rapids, Ia., November 3, 1895, he enlisted as a Reserve ensign March 24, 1917, attained rank of lieutenant commander. Downed in combat, he was prisoner of war until Armistice. For his war services Mr. Gates was awarded the U. S. DSM, English DFC.

NAVAL aviation is literally vital to the Navy. The Navy recognizes this fact and seeks in every way to assist the progress of its air arm, in order that one of its most essential components may be ready to meet any demands. Naval air operations are intertwined so closely with those of the Fleet, and are of such importance, that the necessity for Naval aviation continuing as an integral part of the Navy is recognized generally, both by the Naval service and the general public. The position of the Secretary of the Navy as head of the entire Navy, Naval aviation included, symbolizes this fact.

The office of the Assistant Secretary of the Navy for Air has the duty, under the direction of the Secretary of the Navy, of supervising Naval aviation, of co-ordinating its activities with other Governmental agencies and of performing such other duties as may be assigned by the Secretary of the Navy. The degree to which this duty is accomplished is measured by the manner in which Naval aviation performs its tasks.

Naval aviation has a long and splendid record of achievement. It has come to be regarded, and rightly so, as the world's outstanding Naval air arm. It is the duty of myself and of every officer and man in Naval aviation to keep it so. To do this, it is necessary that we hold our course, with all due pride in past achievements, but at the same time with a relentless striving for perfection and with minds open to new ideas, eager to take advantage of lessons learned from the present European conflict and elsewhere, and ready to utilize new inventions, new materials and new machines as they appear. By hard work and unremitting application, we are confident that we can justify the trust placed in us and discharge our duty to the Navy and through it to the American people. This we propose to do.

☆

NAVAL OPERATIONS and AVIATION

The U. S. Navy today surpasses the world in its use of aircraft. Our Chief of Naval Operations here outlines the vital role of aviation in maritime warfare.

NAVAL OPERATIONS AND AVIATION

by Adm.
HAROLD R. STARK

As Chief of Naval Operations, Admiral Stark can look back on more than four decades of personal experience in the service, to guide him in vital decisions affecting the movement and disposition of the U. S. Fleet. Born in Wilkes-Barre, Pa., November 12, 1880, and appointed to the Naval Academy in 1899, he was awarded the DSM for exceptional World War I services.

THE year 1941 finds the United States Navy in the midst of a great expansion program formulated to prepare it to meet its responsibilities under the world conditions which now exist, and under the even more unfavorable conditions which may be created if further military successes are achieved by those nations which practice forceful military conquest of peace-loving peoples. In planning the Naval expansion program, both the Congress and the Navy Department were guided by the lessons of hostilities abroad, as well as by the results of our own peacetime study and development of the art of Naval and amphibious warfare in the light of the great improvements in technical weapons and equipment which have taken place and which are now in prospect.

The United States Navy long has been foremost among the navies of the world in its concept and in its development and use of air strength as a fundamental requirement for success in Naval operations. The events of the present war have served repeatedly to emphasize the correctness of this concept.

Separated as we are from our probable enemies by the Atlantic and Pacific Oceans and by the Arctic regions, the defense of the United States is primarily a maritime problem. It is a problem of which the solution requires the effective use of Naval forces to control and protect our sea approaches and sea communications, and which requires the effective use of Army forces to hold the continental and island areas which serve as bases for our Naval forces and which might serve as bases for the extension of hostile military power into the Western Hemisphere or into other regions from which the safety of the United States might be threatened. Our defense problem being so largely maritime, it is logical that there should be found in this country the most thorough adaptation of aeronautical development to Naval use.

"Naval aircraft are operated as integral parts of our fleets and of our coastal forces." Below: a Fleet review at San Diego.

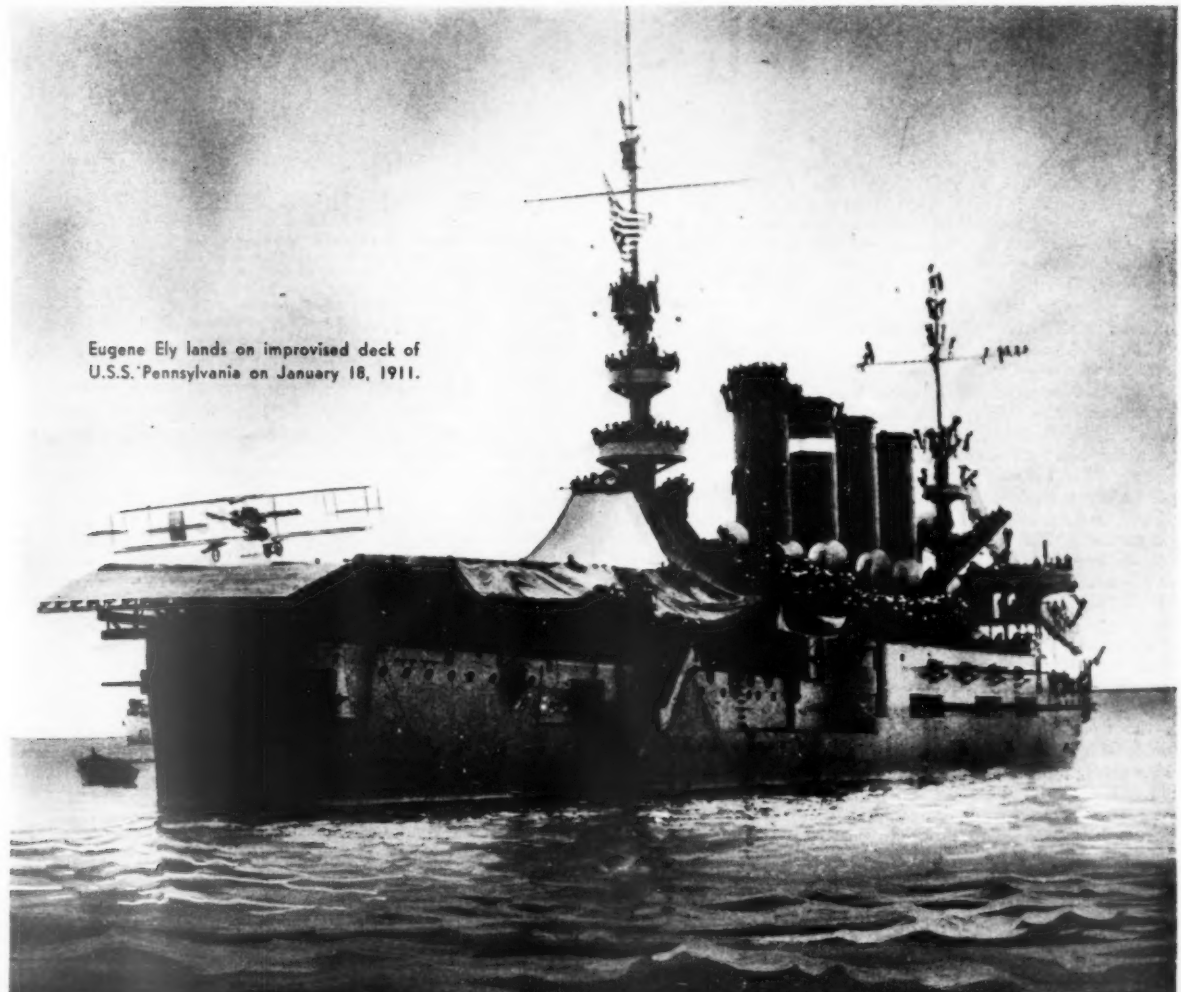
The increases in the effectiveness of aircraft which have taken place, and which are anticipated to occur, have caused the expansion of Naval aviation to take place in a much greater proportion than the expansion of Naval surface forces, the aviation expansion being on the order of one to five while other units are being expanded in a ratio slightly less than one to two. This expansion in strength will be none too great to meet the essential needs of the Navy for its own aircraft to perform purely Naval functions.

Naval aircraft are operated as integral parts of our fleets and of our coastal forces. The principal concentration of air attack power is found in the carrier divisions of the fleets. Aircraft carriers, which are themselves highly mobile, furnish a means for moving quickly to any required area their embarked complements of high performance aircraft—fighters, dive bombers and torpedo planes—which can then conduct flight operations as required. The present program includes an increase in our carrier strength to a total of 18. These 18 aircraft carriers together with supporting and protective forces of cruisers and destroyers will constitute a most powerful and important element in our Naval strength. In the design, construction and operation of these ships and their aircraft, there will be found the finest co-ordination and association of the surface and air elements of our power at sea. The extent to which it is necessary to provide surface strength to make these carrier aircraft fully effective illustrates the interdependence of the surface and air elements of our Naval strength.

For purposes of air patrol at sea there have been developed in this country, by means of continuous and progressive evolution since the first World War, the patrol bomber seaplanes which form the equipment of our long-range patrol squadrons. These squadrons, operating both from permanent shore stations and from tenders in outlying anchorages, provide the Navy with a highly effective force capable of effective scouting and patrol over wide sea areas, and of attack with bombs and torpedoes on enemy units when located. The most efficient force for anti-submarine warfare has been found to be a combination of these patrol planes, destroyers and other surface craft suitable for locating and attacking submarines. Likewise, the most efficient force for other forms of scouting has been found to be a combination of patrol planes and cruisers. In both of these uses success depends on joint training gained by long association in the same service.

Our battleships and cruisers are equipped with their own aircraft to be launched from catapults for purposes of scouting, of spotting surface gunfire and of providing local protective patrols whenever required. This procedure places directly under the captain of a fighting ship the aircraft needed to make his gunfire fully effective.

(*Continued on page* 194)



Eugene Ely lands on improvised deck of U.S.S. Pennsylvania on January 18, 1911.

The HISTORY of NAVAL AVIATION

Credit for every major development in naval aviation throughout the world belongs to the far-sighted U. S. Navy.

THE HISTORY OF

by
JOY BRIGHT HANCOCK

Native of Wildwood, N. J., Mrs. Hancock is in charge of the Editorial Research Section of the Bureau of Aeronautics. Respected by her high-ranking associates in the Navy Department, she joined the Navy in 1918 as chief yeoman, first soloed in 1928. Author of a book and numerous articles on aviation, "J. B. Hancock" is widely traveled, is an expert on U. S. Naval aviation.

ON a bleak winter morning—December 17, 1903—a strange scene unfolded at Kill Devil Hill, Kitty Hawk, N. C. Shivering in 27 m.p.h. blasts that cut over the sand dunes, a small group of men stood beside an odd contraption of wood and cloth—a frail contrivance which, with the engine it mounted, represented immeasurable painstaking effort. Its designers—Orville and Wilbur Wright—were now to test its worth, with five faithful friends as witnesses.

Three days before, Wilbur had won, by flip of a coin, first chance to demonstrate the machine's performance. It failed him. Now it was Orville's turn.

Lying flat between the wings, the engine running, he pulled the release wire. The plane shot forward! Silently, Wilbur ran alongside it, balancing it until he was outdistanced. Orville remained aloft 12 seconds, flying 120 feet, landing without mishap. The age-old dream had come true! Man had conquered the last element. Aviation was born!

Two men, through diligence and tirelessness, had found their answer. The following five years they worked constantly toward improvement of design, engine performance, flying technique.

In September, 1908, they gained a demonstration of their machine before Government officials at Fort Meyer, near Washington. Observers for the Navy were Lieut. C. G. Sweet, USN, and Naval Constructor McIntee. They recommended that an airplane, fitted with pontoons, be procured for study regarding adaptability for Naval use. Unfortunately, others in the Service were not so enthusiastic; nothing concrete immediately resulted. But the Navy was interested. Two years later, Capt. W. I. Chambers, USN, as observer at aviation meets at Belmont Park, N. Y., and Halethorpe, Md., impressed with the skill of the pilots and the maneuverability of the airplanes, believed others in the service would change their attitude toward aviation could they see a convincing demonstration. Accordingly, he approached the Wright brothers, proposing that they fly an airplane from the deck of a battleship. The Wrights did not feel that their machine was ready for such a hazardous test.

The same year of the Wrights' Fort Meyer demonstration, Glenn Curtiss had opened a bicycle shop in Hammondsport, N.Y., and a short time later was building lightweight engines for his bicycles. His success was noticed by Thomas Baldwin, who was building airships in California and meeting unsolvable engine difficulties. Baldwin approached Curtiss; the result was a collaboration. Soon they were making airship records throughout the country. Meanwhile, Curtiss, with a group of others, became interested in heavier-than-air craft, in which the Curtiss engine was used exclusively. Curtiss finally produced his own airplane—the *Junebug*. With this and subsequent planes of his design he became internationally known as a leading aviation figure.

Captain Chambers proposed the Naval demonstration to Curtiss, who agreed to attempt it. A wooden platform 60 feet long was constructed on the bow of the *U.S.S. Birmingham* at Hampton Roads, Va. Eugene Ely, a Curtiss pilot, was selected for the task. On November 14, 1910, he opened his engine's throttle, roared the length of the platform and took to the air. The Naval officers aboard the ship stood tense as the plane gained speed for take-off, relaxing only when Ely disappeared landward, the beat of his motor sounding fainter and fainter. Privileged to glimpse the future, they visualized the possibilities of Naval aviation.

Curtiss, sensing the favorable impression, immediately offered to teach, without cost to the Government, a Naval officer to fly. The Navy accepted. On December 23, 1910, Lieut. T. G. Ellyson was ordered to report to the Curtiss camp at San Diego, Cal.

Never one to let enthusiasm lag, Curtiss arranged for an additional, more forceful demonstration. A platform 120 feet long, 30 feet wide, was built upon the stern of the *U.S.S. Pennsylvania*, anchored in San Francisco harbor. Crude arresting gear—lines with sandbags attached to each end—were laid across this platform. Ely again at the controls, a cumbersome hook attached to his plane, took off from the Presidio in San Francisco, landed aboard the *Pennsylvania*, turned about, took off, returned to shore. The aircraft carrier was born. . . .

Convincing though these demonstrations were, a place of real value in Naval usage had not been worked out. Some saw only certain guns made useless because of platform interference. Not necessarily the sentiments of the "die-hards," the criticism was constructive—airplanes should further, not lessen, the efficiency of fighting ships.

Nevertheless, reports concerning the demonstrations led the Secretary of the Navy to write Curtiss that when he

Naval aviation came into being in 1912 with purchase of this Curtiss, designated Navy's flying boat Number One.

Predecessor of today's modern seaplanes, this 1916 Curtiss seaplane was flown again in 1928 by Navy pilot at Anacostia.

NAVAL AVIATION

could fly an airplane alongside a battleship, alight on water, and be hoisted aboard without using any false deck, the airplane would be practical for Naval use.

Curtiss accepted that challenge. Aided by Lieutenant Ellyson, who was learning to fly, and other members of his group at North Island, he went to work. Float after float, each embodying new ideas, was built, tested, discarded. Finally, on January 26, 1911, his airplane was ready. The *U.S.S. Pennsylvania* was in San Diego harbor, the stage was set, and on February 17, 1911, Curtiss successfully met the specifications laid down by the Secretary of the Navy. Later, when lowered to the water by crane, he took off and flew back to his camp.

Here was born the feasible and successful idea for operation of aircraft from battleships and cruisers. True, the catapult had not yet entered the picture; but its development was immediately undertaken.

Apparently convinced by these demonstrations, the Navy made recommendations to Congress resulting in an inclusion of $25,000 for aviation in the 1911-1912 Naval Appropriation Act. In March, 1911, Captain Chambers, detailed to the Bureau of Navigation, was directed to devote his entire time toward the establishment of a Naval aviation service.

While Naval officers who had seen actual demonstrations could readily visualize the potential value of aviation to the Fleet, unfortunately they were a very small number; so Captain Chambers found his new assignment, which called for the co-operation of all bureaus, a difficult one.

His first step was to secure planes and pilots. To the Wrights, a contract was awarded for one airplane; to Curtiss, a contract for two. The awards stipulated that one pilot was to be trained for each plane. Accordingly, in the spring of 1911, Lieut. John H. Towers, USN, reported to the Curtiss camp, Lieut. John Rodgers, USN, to the Wrights, Lieutenant Ellyson having received the training. Shortly afterwards, a camp was established at Greenbury Point, near Annapolis, Md., and the first Naval aviation organization began operations. Ens. V. D. Herbster was the first student to report for training. The following year, six additional officers were assigned to Naval aviation: Naval Constructor H. C. Richardson, USN; Lieut. (jg) G. de C. Chevalier, USN; Lieut. P. N. L. Bellinger, USN; Ens. W. D. Billingsley, USN, and First Lieuts. A. A. Cunningham and B. L. Smith of the Marine Corps. The Navy now had 10 pilots, three airplanes.

Progress was rapid. Many record-breaking flights contributed to the world history of aviation. Lieutenant Rodger's round-trip flight from Annapolis to Washington, D. C., including College Point, Baltimore, and Havre de Grace, Md.; Lieutenant Ellyson and Lieutenant Tower's flight from Annapolis to Fortress Monroe, Va., and return. Lieutenant Towers also established a world's endurance record for seaplanes by remaining aloft six hours, 10 minutes.

During this period Curtiss, assisted by Lieutenant Ellyson, attempted to solve the problem of a launching device for airplanes operating from ships. The first effort, carried out at Hammondsport, N. Y., consisted of a steel cable, running from an elevated platform to the water, designed to fit a groove which had been incorporated in the pontoon of the airplane. Ellyson actually made several take-offs by sliding down the cable, but he and Curtiss early agreed that the idea was not practical for shipboard use.

Captain Chambers then revived the catapult idea. One was designed and built at the Navy gun factory, Washington, D. C., in 1912, and set up on the Santee dock at the Naval Academy. The trial was unsuccessful. The entire project was then turned over to Naval Constructor Richardson, with orders to make it work. Three months later, the catapult and Lieutenant Ellyson were ready at the Washington Navy Yard, and on November 12, 1912, the first successful catapult launching was accomplished.

Catapult installation today allows planes to be launched in any direction without interfering with the ships other functions. Hazardous as is this duty, not one fatality has occurred, during the thousands of launchings accomplished, due to malfunctioning of the gear.

The Navy, following closely the purchase of its first airplane, constructed a wind tunnel at the Washington Navy Yard where valuable aerodynamic data were obtained. Along with this project a model basin was constructed, the necessary instruments being secured for obtaining information concerning hulls and floats. Naval Constructor H. C. Richardson conducted a series of tests on model airplane floats, giving the world the first scientific data on this subject.

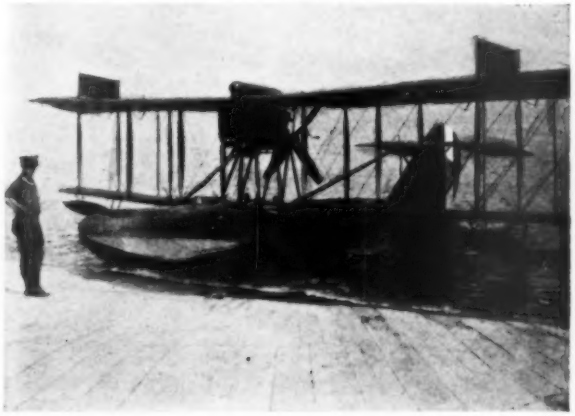
The new pilots in training were working alongside the original three. Lieutenant Bellinger at Annapolis flew a Curtiss seaplane to an altitude of 6,000 feet in 45 minutes, thereby breaking another world's record. First Lieut. B. L. Smith, USMC, made the first successful flight in an amphibian by taking off water, landing on a field and again alighting on water.

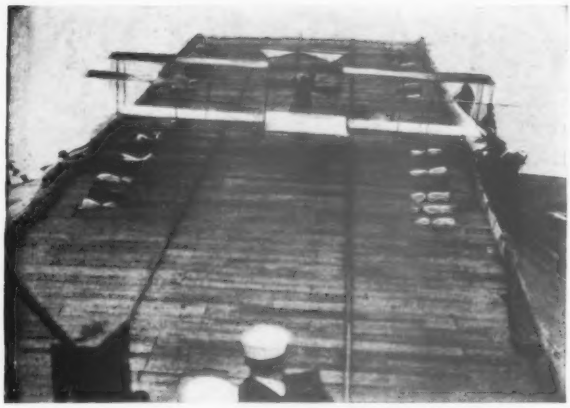
When the Fleet went south in January, 1913, for annual winter maneuvers, Naval aviation, under command of Lieutenant Towers, accompanied it for the first time. The entire period was spent in experiments and tests pertaining to coordination of aircraft with Fleet operations. Problems of scouting to locate enemy vessels, mine fields and submarines were so successfully conducted that many officers skeptical of the airplane's usefulness definitely changed their opinion.

So profound was the reaction that the Secretary of the Navy,

Curtiss's "America" had 72-foot wing span, weighed 5,500 pounds. Its 1913 design proved basis for patrol types.

By 1917 Naval aviation had progressed to the HS-1 but declaration of war found us ill-equipped for air action.





Primitive arresting gear used for Ely's landing on the U.S.S. Pennsylvania in 1911 was forerunner of modern carrier gear.

With a bicycle tube providing his flotation gear, Ely is ready for take-off from the Pennsylvania's improvised deck.

in October, 1913, appointed a board, with Captain Chambers as chairman, to make a survey of aeronautical needs and to establish a development policy. One of the board's most important recommendations called for establishment of an aviation training station at Pensacola, Fla. The recommendation approved, the first United States Naval air station arose in 1914 upon the site of an abandoned Navy yard. Comm. H. C. Mustin, USN, was placed in command and all planes and pilots were ordered there for duty. A row of 10 hangars was set up along the sandy beach, wooden ramps running from each tent to the water. Fifteen pilots and a startling collection of 11 airplanes constituted Naval aviation.

Because of the scarcity of properly trained pilots the Navy Department, at Curtiss's request, assigned Lieutenant Towers to duty at the Curtiss plant as test pilot. In addition to dual controls, overhanging wings and many other projects which were developed during this period, Towers and Curtiss found time to discuss and investigate the possibility of building an airplane capable of making a transatlantic flight. In February, 1913, the Navy Department granted an extension of Towers' services, and the two men designed and started the construction of the two-engined flying boat, *America*. Outbreak of the war in Europe precluded the projected flight, but much valuable data had been obtained. As a matter of fact, from the basic design of the *America* came both the British- and American-designed H-12, H-16, HS, and F-5-L types used during and after World War I with great success.

In 1914, Naval aviation received its first test of war action when the *U.S.S. Mississippi* and *U.S.S. Birmingham* were ordered to Vera Cruz in connection with the occupation of that city. Although not equipped for land operations, the units scouted over trenches and around the city on 43 consecutive days. Lieutenant Bellinger's plane, during one flight, was struck by rifle bullets—the first instance of a military airplane of the United States operating in the face of hostile fire. Reports brought in from these scouting missions did much to coordinate the activities of the Army and Navy.

The declaration of war in this country in April, 1917, found the Navy faced with the problem of immediate expansion. The situation in the flying branch was particularly acute, as quantity production of airplanes was unknown. Existing aircraft manufacturers could not handle the orders. The Navy immediately undertook construction of an aircraft factory at the Philadelphia Navy Yard. Ground was broken on August 6, 1917; 110 days later, November 28, the factory stood completed, with all machinery installed. At the time of the Armistice, 183 twin-engined flying boats had been delivered by the factory, many of which had been sent abroad.

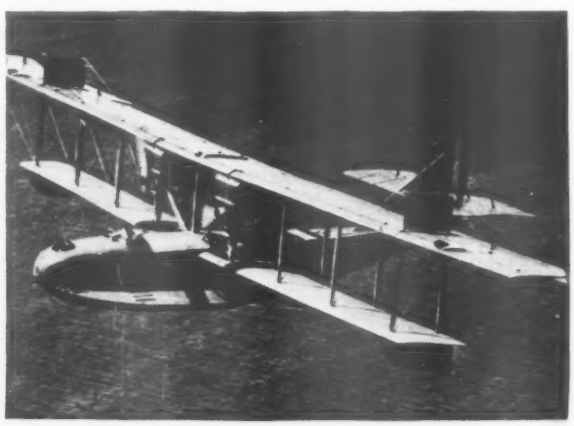
On the day war was declared, the Navy had one air station, 38 Naval aviators, 163 enlisted men, and 54 airplanes. On November 11, 1918, 21 schools and stations were in operation in the United States; 22 aviation bases had been established abroad; 2,107 airplanes, 3,049 officers, and 43,452 enlisted men were attached to the aviation establishment. In addition, there were 3,912 student aviators undergoing training. During the war, 1,237 officers, 16,287 enlisted men, and approximately 500 aircraft had been sent overseas.

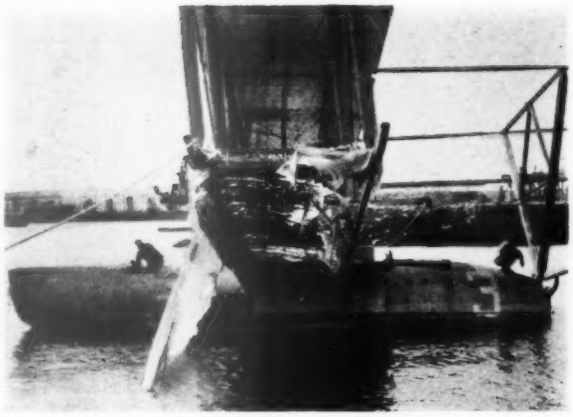
Any account of Naval aviation includes Marine Corps aviation. It has always been a definite and important part of the Navy. The group of four officers and 30 enlisted men which comprised Marine Corps aviation in April, 1917, had increased to 272 officers and 2,180 enlisted men 17 months later. Four Marine squadrons operating in France accounted for eight enemy planes and the dropping of over 5,000 pounds of bombs on 57 raids over enemy lines.

The end of the war found Naval aviation still on the upswing

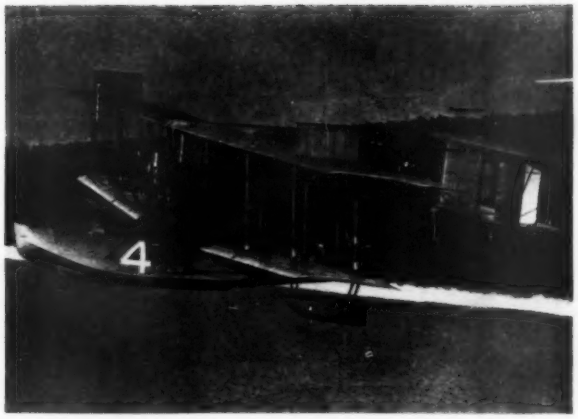
Blazing the aerial track across the Pacific Ocean in 1925 was this Navy PN-9 with Comm. John Rodgers at the controls.

Advantages of two-engined flying boats were recognized early in Naval aviation. Boat below is H-16 type of 1917.





Both the NC-1 and NC-3 made forced landings at sea. Though the former sank, the NC-3 (above) taxied clear to the Azores.



Most famous Navy flying boat of the time was NC-4, only one of three starters that reached England. Date: May 31, 1919.

of the pendulum. Planes and pilots were going overseas in great numbers. Production had hit undreamed-of proportions. One of the many projects underway was construction of large flying boats to be delivered by air. Curtiss, early in 1917, had accepted the contract to build, as the trial lot, four four-engined flying boats designed to carry a crew of five, and having a gross weight of 28,000 pounds and 126-foot wing span. The first of the lot, the NC-1, was test-flown in October, 1918. The following month the Armistice was signed; the need for delivery abroad was nullified.

The Navy Department, however, decided to carry out the original plans as a practical test of the plane's capabilities. Accordingly, on May 16, 1919, the NC Division, comprising the NC-1, NC-3, and NC-4, under command of Comm. J. H. Towers, USN, took off from Trepassy, Newfoundland, for the attempt. Encountering heavy fogs, the NC-1 and NC-3 landed near the Azores to determine their positions. Heavy seas damaged them, preventing their taking off. The NC-1 sank after her crew and commanding officer, Lieutenant Commander Bellinger, had been rescued by a passing freighter. The NC-3, Commander Towers commanding, sailed over 200 miles to the breakwater of Ponta Delgada, then used the remaining gasoline to taxi into harbor. The NC-4, Lieut. Comm. A. C. Read commanding, reached Horta on May 17, Ponta Delgada on May 20, Lisbon, Portugal, on May 27, and Plymouth, England, on May 31—the first airplane to fly across the Atlantic.

During the decade following the World War, sound economics demanded employment of surplus war material. Production of new types of planes was curtailed. Technical and operational ingenuity, however, found various outlets, of which the aircraft carrier was one. The collier *Jupiter*, renamed *U.S.S. Langley*, served as a guinea pig in this field. The lessons learned were incorporated first in the *Saratoga* and *Lexington*, then in the *Ranger*, the first ship to be built from the keel up as a carrier. Among other most important post-war achievements by the Navy was development of the air-cooled engine and substitution of metal alloys for wood construction.

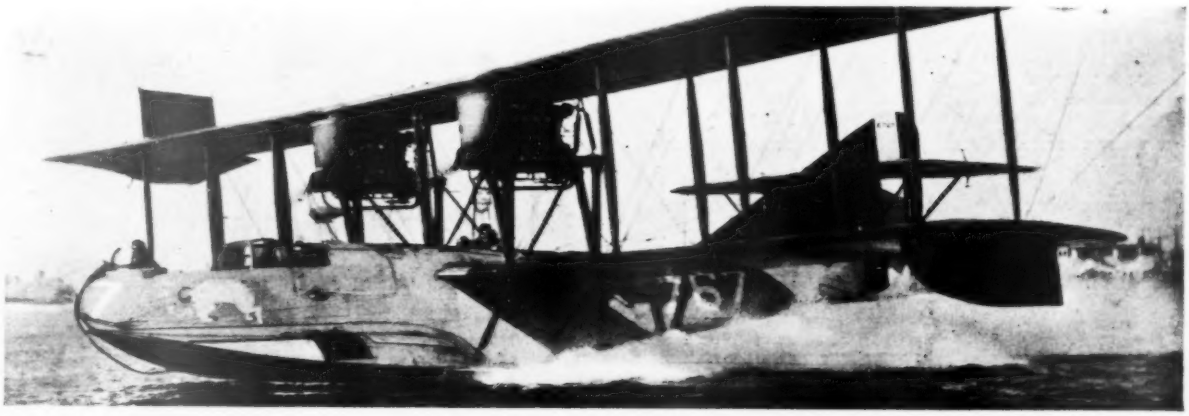
It was realized during this time that in order to keep abreast of aviation developments and contribute to that development, a reorganization of aviation within the Navy was needed. Accordingly, on July 12, 1921, an act of Congress authorized the Bureau of Aeronautics, and on September 1, 1921, President Harding appointed Rear Adm. W. A. Moffett as its first chief.

By 1925 it had become definitely clear that a continuing policy of peace production must be set up for the Navy if that service was not to fall woefully behind the developments going on in aviation throughout the world. President Coolidge therefore appointed a committee to decide the best application of aircraft in Naval defense. This board, generally known as the Morrow Board, recommended a five-year building program providing for 1,000 useful airplanes; creation of the position of Assistant Secretary of the Navy for Aeronautics; and construction of two rigid and one metal-clad airships. This five-year plan had a most beneficial effect on Naval aviation. It set a definite strength goal, enabling many civilian aircraft manufacturers to stay in business. The wisdom of this measure may be thoroughly appreciated when it is realized that those companies are today producing planes for our defense and for nations fighting totalitarian governments.

It is necessary at this point to go back in our history in order to include concurrent development of lighter-than-air craft in the Navy. The first acquisition of this type was in 1915—a non-rigid, designated the "B" type. The "C", "D", "E", and "F" types followed in due course, the outstanding being the "C" type. Rigid construction was adopted for larger airships

(*Continued on page* 218)

Produced in quantity for the Navy in 1917, the Curtiss-built H-12 was developed from "America" design. Used largely for Atlantic coastal patrol, H-12 had shorter range than succeeding F-5-L, carried a crew of four.



The Bureau of Aeronautics

Uncle Sam's powerful Naval air arm is operated and controlled by the hard-working, progressive BuAero.

by Rear Adm.
JOHN H. TOWERS

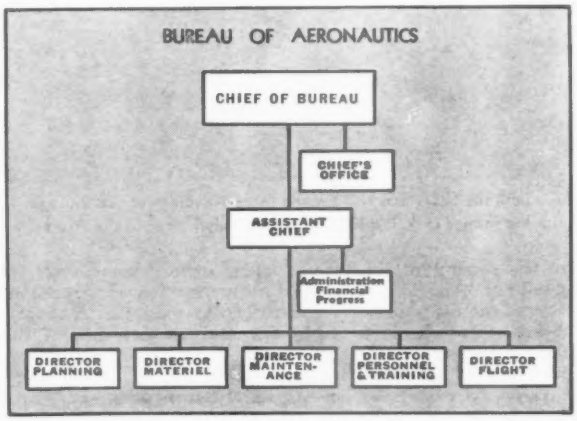
Chief of the Bureau of Aeronautics, Rear Admiral Towers was graduated from the Naval Academy 1906, became qualified pilot in 1911. Commanded Navy's aviation unit at Vera Cruz in 1914. Assigned to supervise organization of Naval flying corps in 1916. Has commanded numerous units since, including U.S.S. Saratoga. He was born in Rome, Ga., January 30, 1885.

TO UNDERSTAND the organization of Naval aviation and its purpose, which is to perform successfully all missions that may be assigned, it is essential first to realize that aviation is inseparably woven into the structure of our Navy as a whole.

Its mobility is derived primarily from the mobility of the surface units of the Fleet upon which it depends for launching and landing platforms, for ready maintenance facilities, for gasoline and oil and for spare parts and materials needed to sustain the Naval air effort in any theater in which it is found necessary to apply Naval power.

The relations of the various types of Naval airplanes to the Fleet find a close parallel in functions performed by a number of surface types long recognized as essential to a balanced Fleet organization. Thus the fighting plane, based on aircraft carriers, substitutes for the antiaircraft gun at ranges beyond the effective range of fire of these surface installations. The observation plane, carried on battleships and cruisers, substitutes for the observer in the fighting top when the target lies over the horizon or when visibility to surface view is artificially or naturally impaired. The torpedo plane substitutes for the destroyer when conditions favor a swift air-borne attack by this weapon. All bomber types, which include carrier-based planes and large patrol bombers, substitute for the major and secondary batteries of surface units when ranges preclude the effective use of ship's gunfire. Air scouting, patrol and reconnaissance, which are capable of being performed by practically every type of combat Naval airplane, supplement and extend, but as in all other cases do not displace, the corresponding functions of the various surface units upon which the planes are based.

Examination of the part which Naval aviation must play in any form of Naval warfare will indicate clearly its dependence upon surface effort and surface control for its most efficient and effective application. This dependence carries with it the corollary that in sea warfare responsibility for and authority over every type of unit which participates in the joint enterprise, whether it operates below, upon or above the surface, must be vested in a surface commander. He alone, by virtue of the installations, equipment and sustained endurance of his flagship, possesses the various media through which intelligence is received and control, essential to the co-ordination of the over-all effort, is exercised.



Organization chart of Bureau of Aeronautics, known by Navy as BuAero.

Our Navy is undergoing what amounts to more than a five-fold expansion of its aviation arm. Before the outbreak of the present European war, its objective was a total of 3,000 Naval airplanes. Its present objective is in excess of 15,000 airplanes and an even greater number of trained Naval aviators to man them. The total number of planes decided upon is not an arbitrary figure. It is a figure reached after exhaustive and meticulous study of Naval strategic requirements. The plan of procurement and expansion is co-ordinated with the ship-building program of Naval vessels to which Naval aircraft ultimately will be assigned.

Let it be understood clearly that Naval officers do not determine the size of the Navy. They do make recommendations based upon their interpretation of the national policies; policies which are the result of the will of the people expressed through their representatives in Congress. To be effective, national policies must be supported by proper Naval measures. Policies can be changed overnight; the composition of the Navy can not. It is for this reason that the Navy does by its very existence, exercise a great influence over policies.

The Naval expansion underway two years ago was based upon the international situation of that time. The situation today is vastly different. As a precautionary measure the Navy has redistributed its forces in a manner deemed to be most expedient, and is forging ahead on a large new program.

In correlating the progress of Naval aviation with that of the surface Navy and in carrying out its materiel duties, the Bureau of Aeronautics has considered both quantity and quality. It is specifically charged with providing the best materiel that authorized funds can procure, with providing aircraft in accordance with operating force plans and with the planning and

(*Continued on page* 182)

COLOR PHOTOGRAPHY

Some of aviation's most beautiful color photos appear on the following 15 pages. Most of these pictures were taken especially for this issue, with Navy co-operation.

Official U.S. Navy Photograph

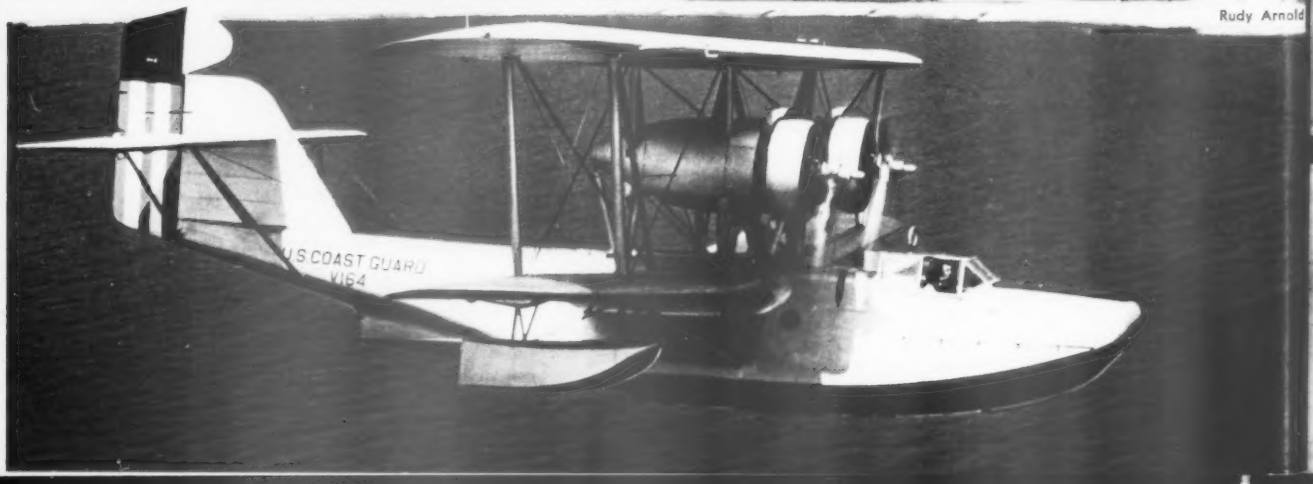
Rear Admiral JOHN HENRY TOWERS

Chief, Bureau of Aeronautics, United States Navy.

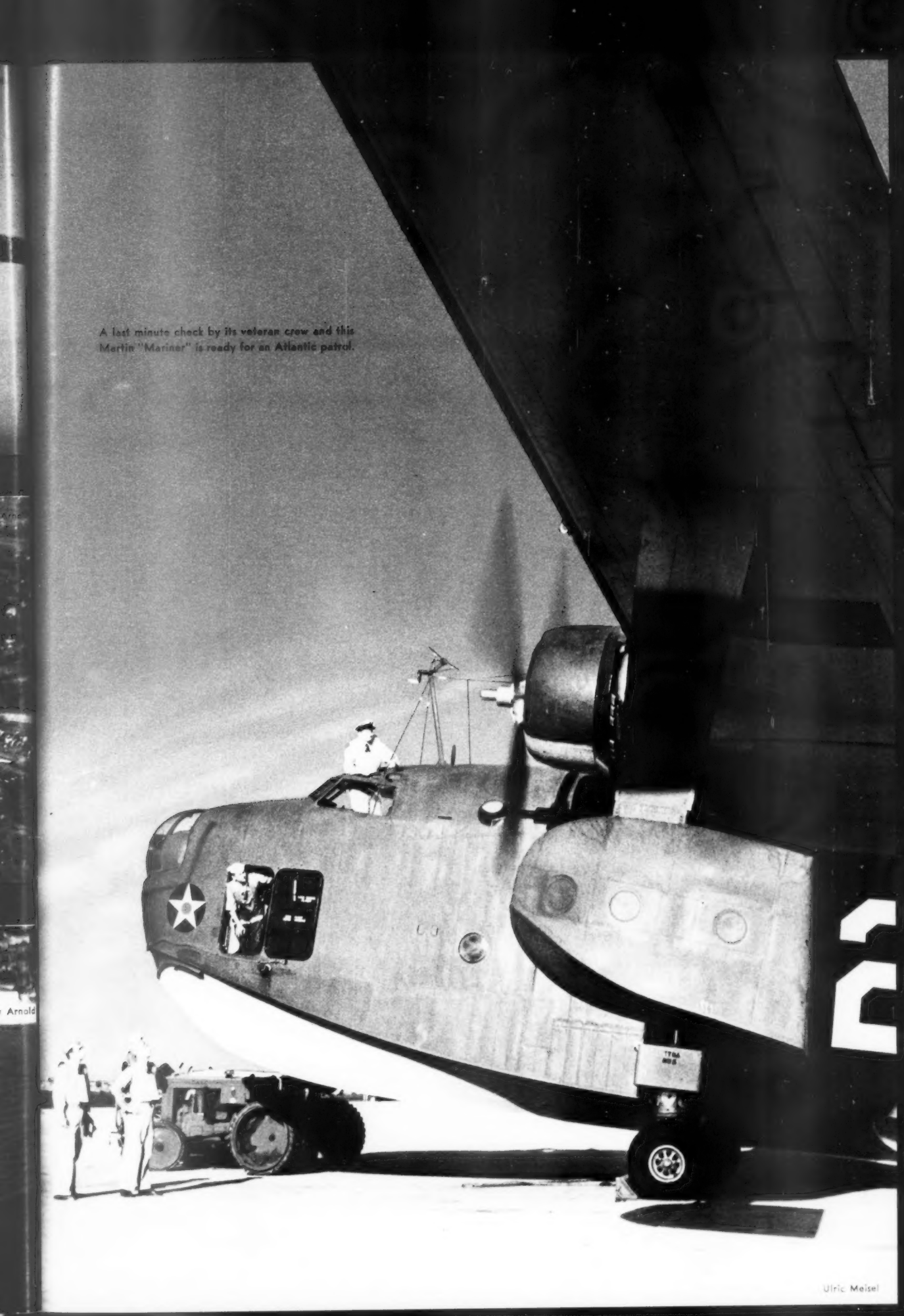
Best-known U. S. Navy patrol bomber is the famed Consolidated "Catalina" (PBY-5). Though comparatively slow, these boats have tremendous non-stop range, currently are a favorite with RAF patrols.

Martin "Mariner" (PBM) is Navy twin-engined patrol bomber. Camouflage replaces above color scheme.

Currently used by Coast Guard is Hall PH-2, an old Navy patrol boat design modernized for rescue work.



Rudy Arnold



A last minute check by its veteran crew and this Martin "Mariner" is ready for an Atlantic patrol.

Ulric Meisel

Vought-Sikorsky's "Vindicator" (SB2U) scout bomber is one of the most potent dive bombers now in use.

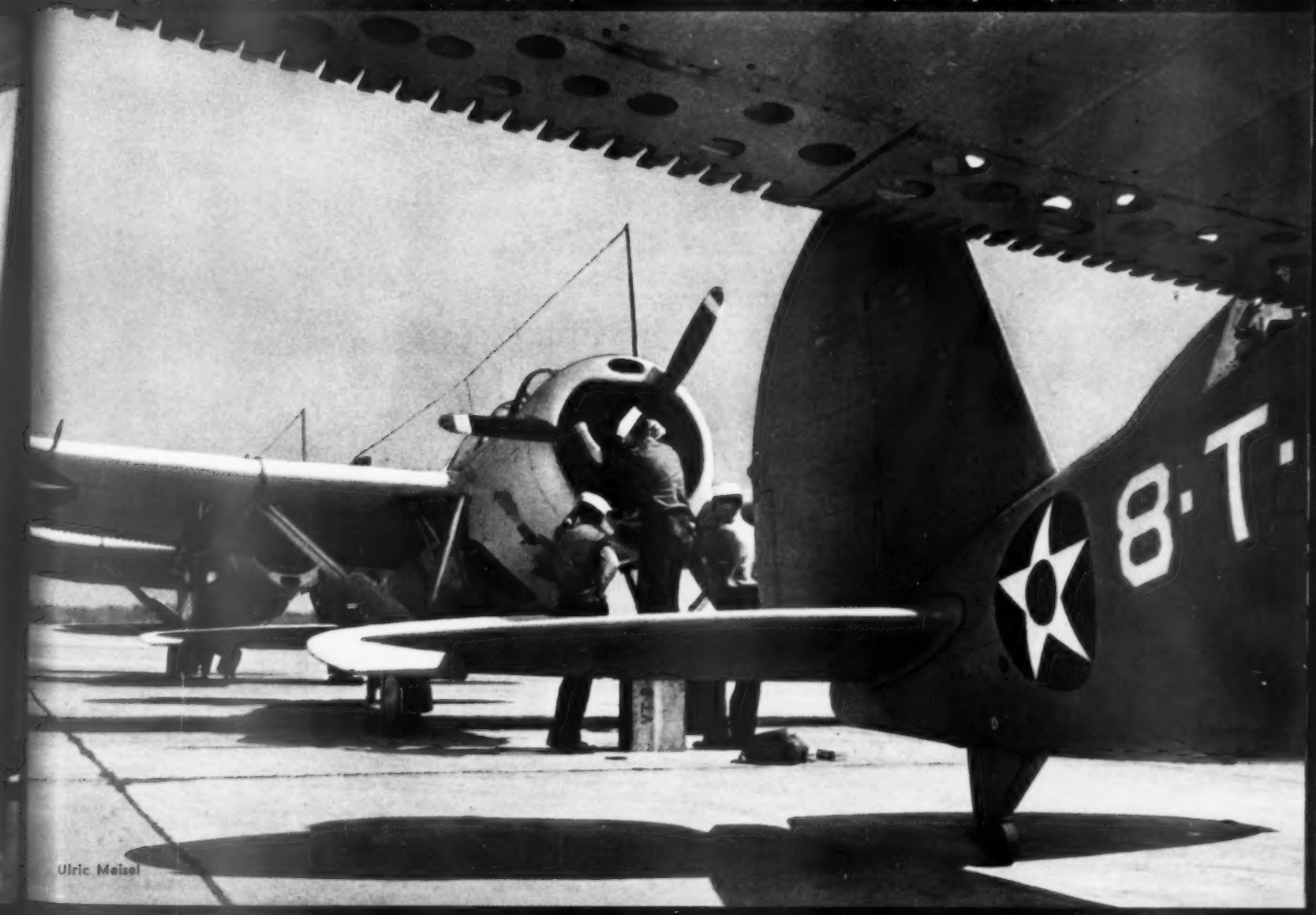
One of the most rugged scout bombers is the Navy Curtiss SBC-4, soon to be replaced by later models.

Rudy Arnold

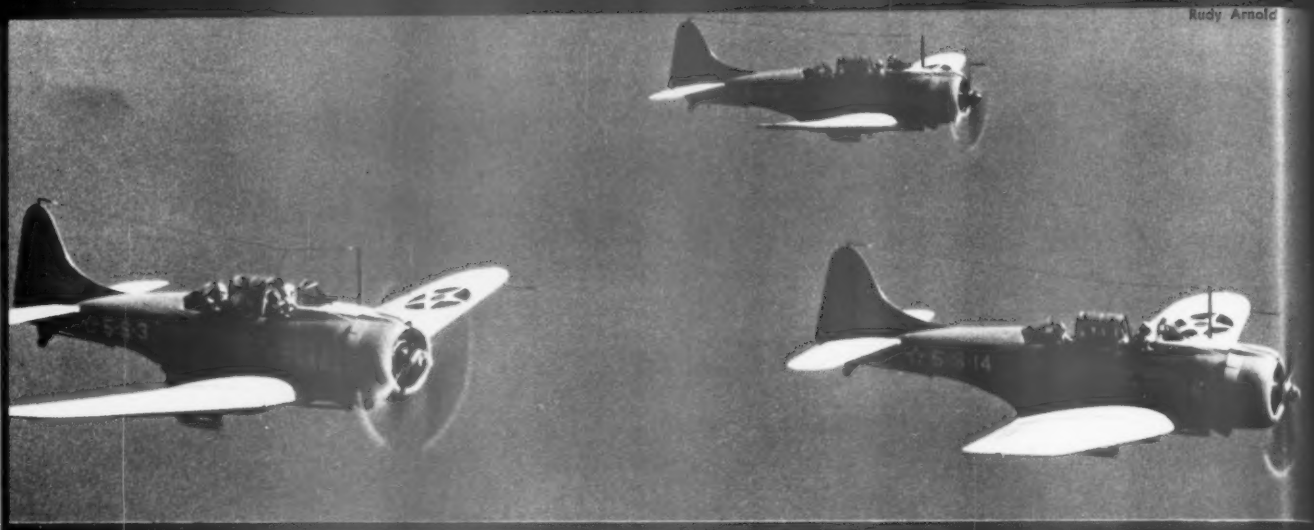
Ulric

Deadliest and newest dive bomber now being built for the Navy is this Curtiss "Helldiver" (SB2C-1).

These SBN dive bombers are Navy-built. Unusual slotted flaps on wing retard speed in power dives.



Ulric Meisel



Rudy Arnold

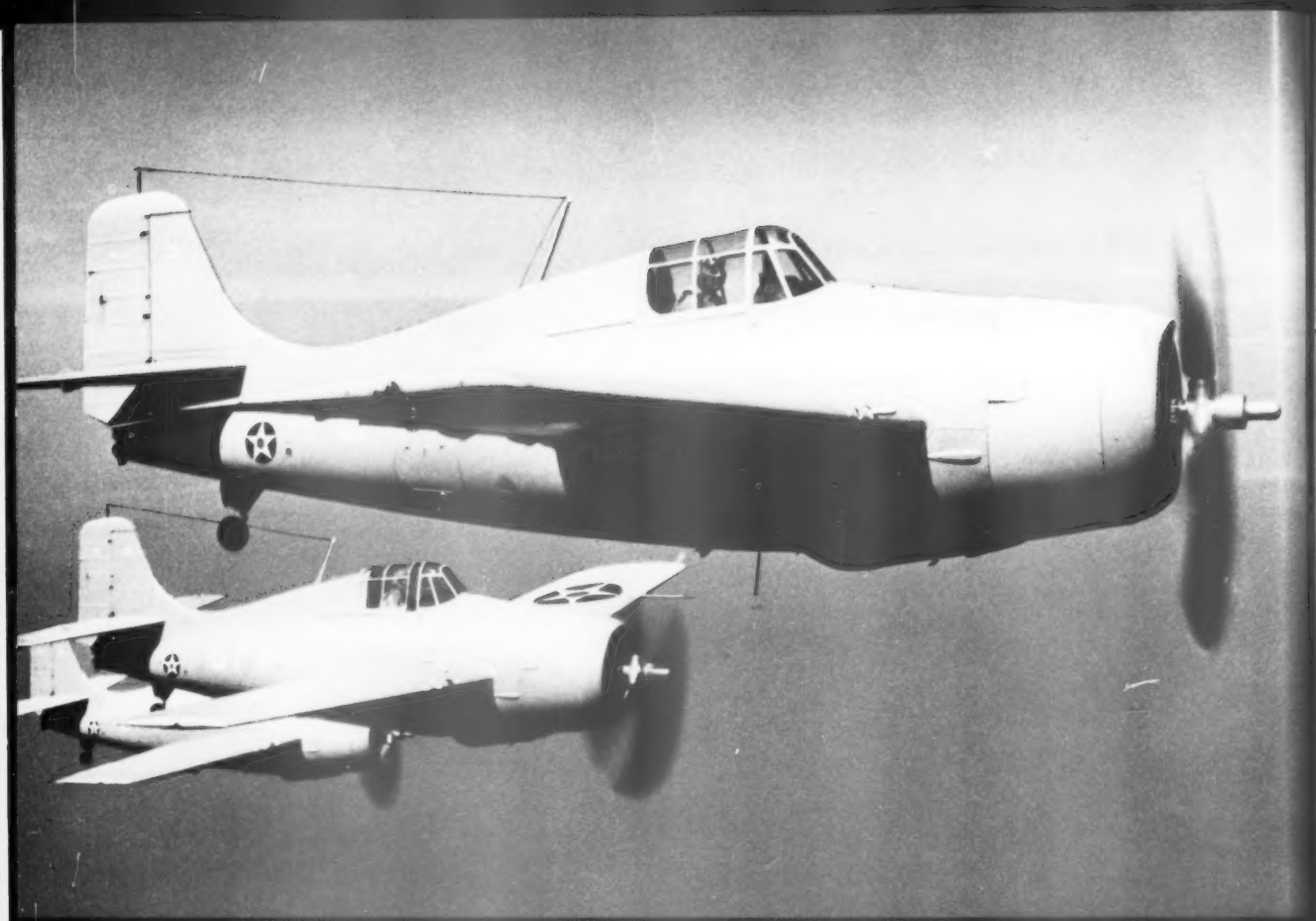
One of world's toughest dive bombers is the new Douglas "Dauntless" (SBD). Recently adopted by the Army Air Forces as A-24, the "Dauntless" is vastly superior to Germany's Stuka. Above planes are from Scouting Five.

Ulric Meisel

Built by the Naval Aircraft Factory, this SBN will be superseded by the new Brewster "Buccaneer" (SB2A).

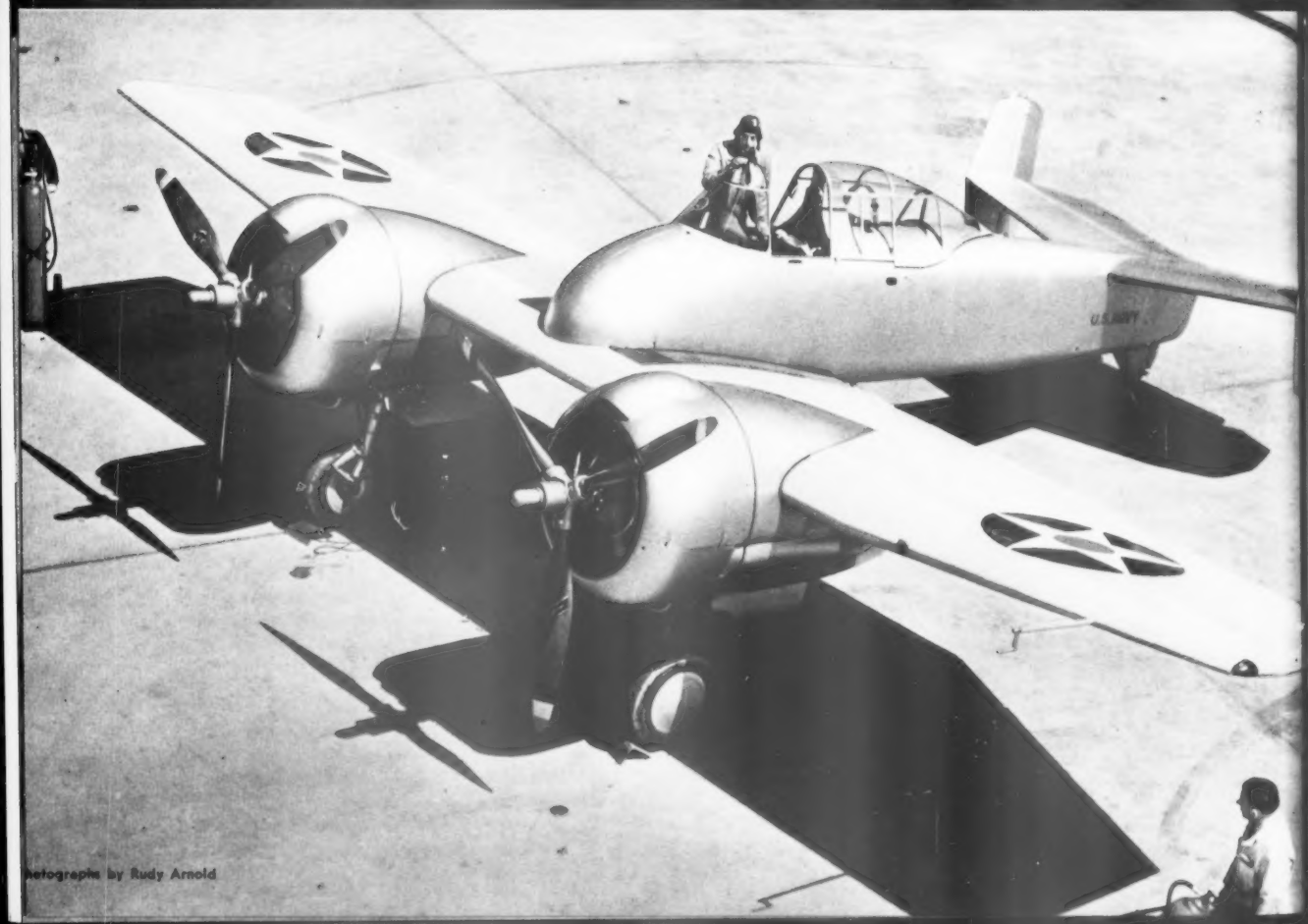
Powerful torpedo bomber currently used in Navy is Douglas "Devastator" (TBD), mostly carrier-based.

Twin eyes of the U. S. Fleet are this Navy pilot and his Vought-Sikorsky OS2U-1 scout observation seaplane.

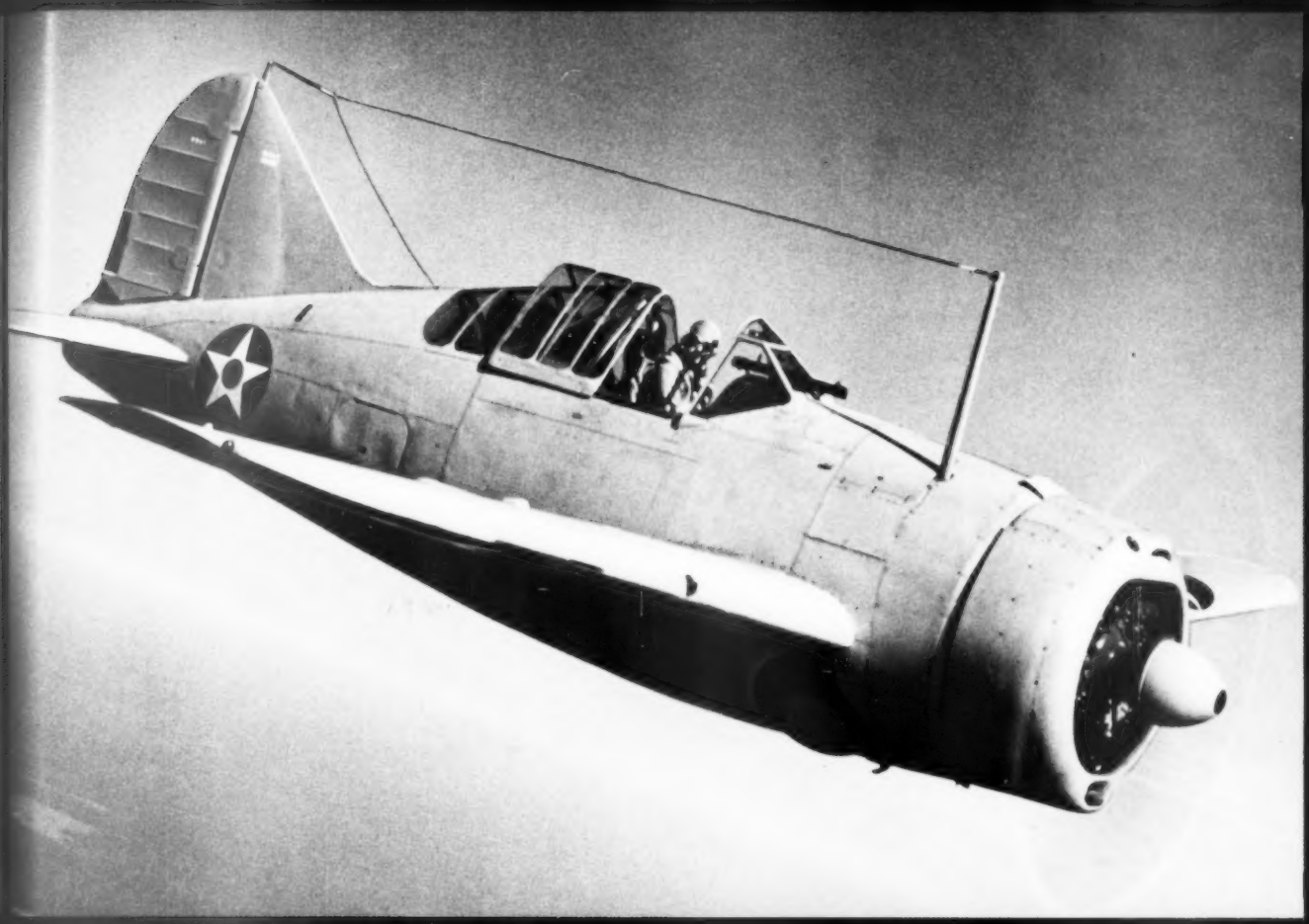


Grumman "Wildcat" (F4F), first-line Navy fighter, is also used by U.S. Marines and RAF Fleet Air Arm.

Slated by Navy for future development is experimental twin-engined Grumman "Skyrocket" (XF5F-1).



Photographs by Rudy Arnold



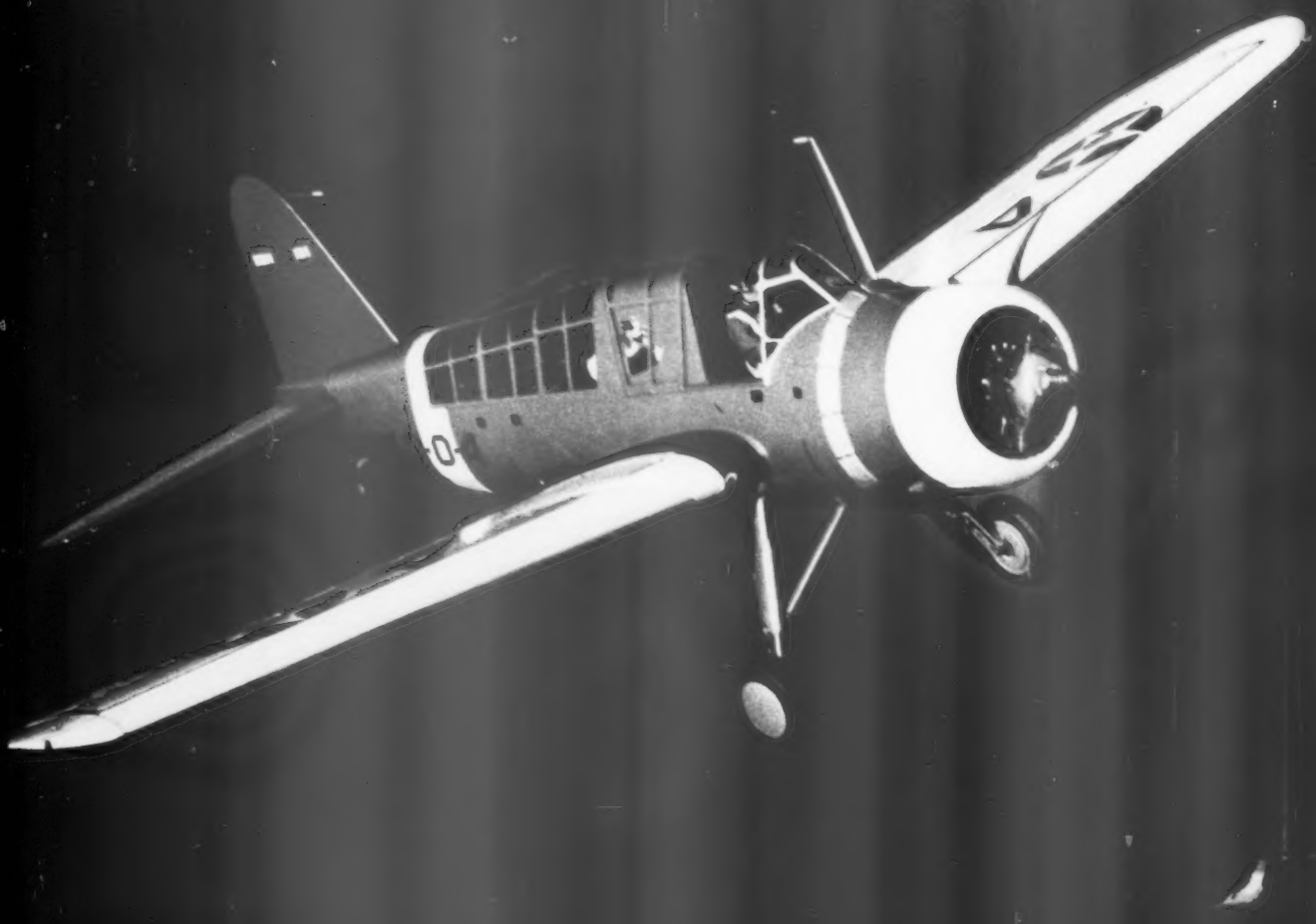
Popular both in the Navy and with the RAF is the Brewster "Buffalo" (F2A-1) carrier-based fighter.

Standard fighter in the Marine Corps, as well as the Navy, is the powerful Grumman "Wildcat" (F4F).

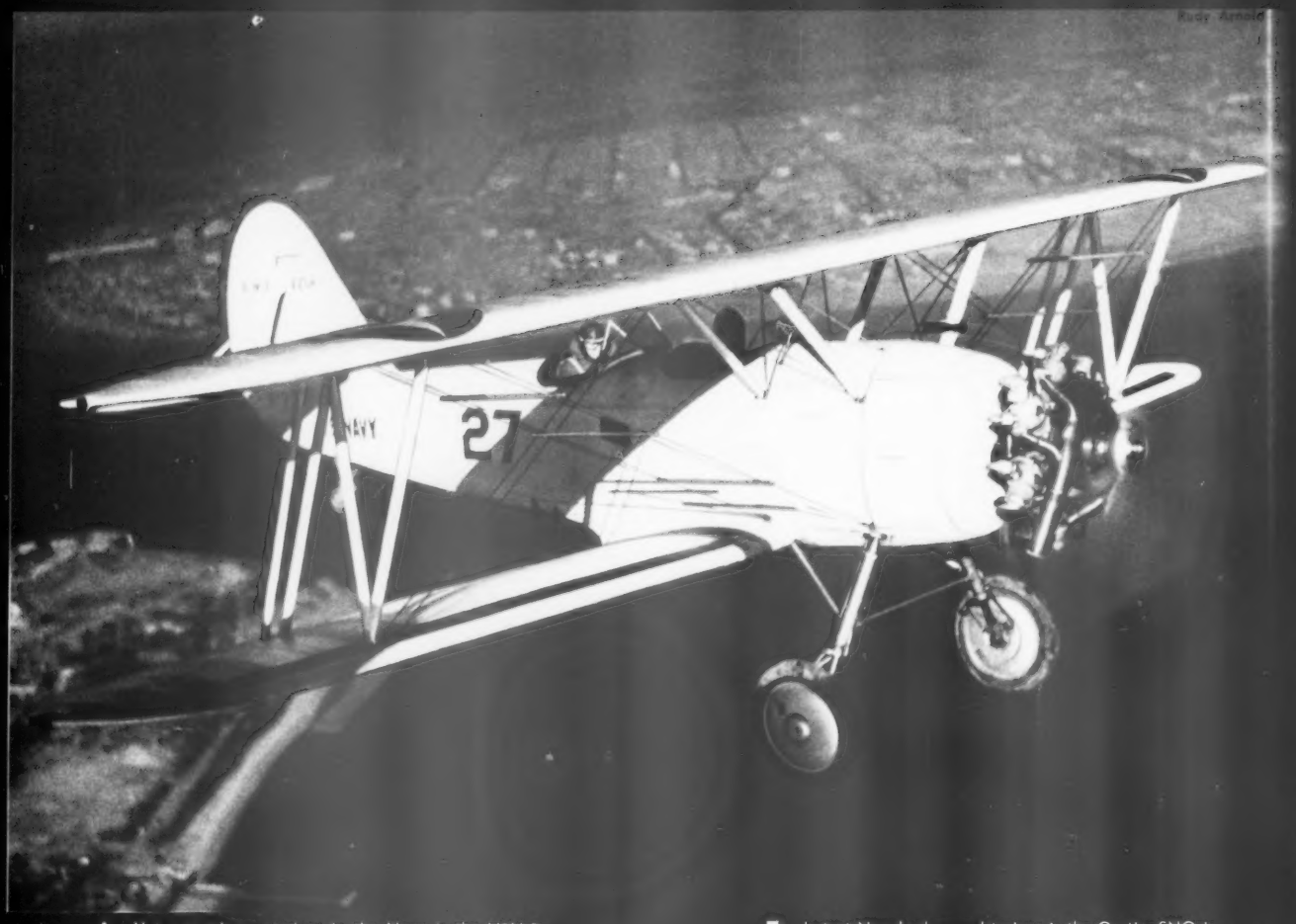
Ulric Meisel

Used aboard battleships, cruisers and carriers, the Curtiss SOC is a standard scout-observation type.

Now officially known as the "Kingfisher," Vought-Sikorsky's OS2U is a new catapult observation type.

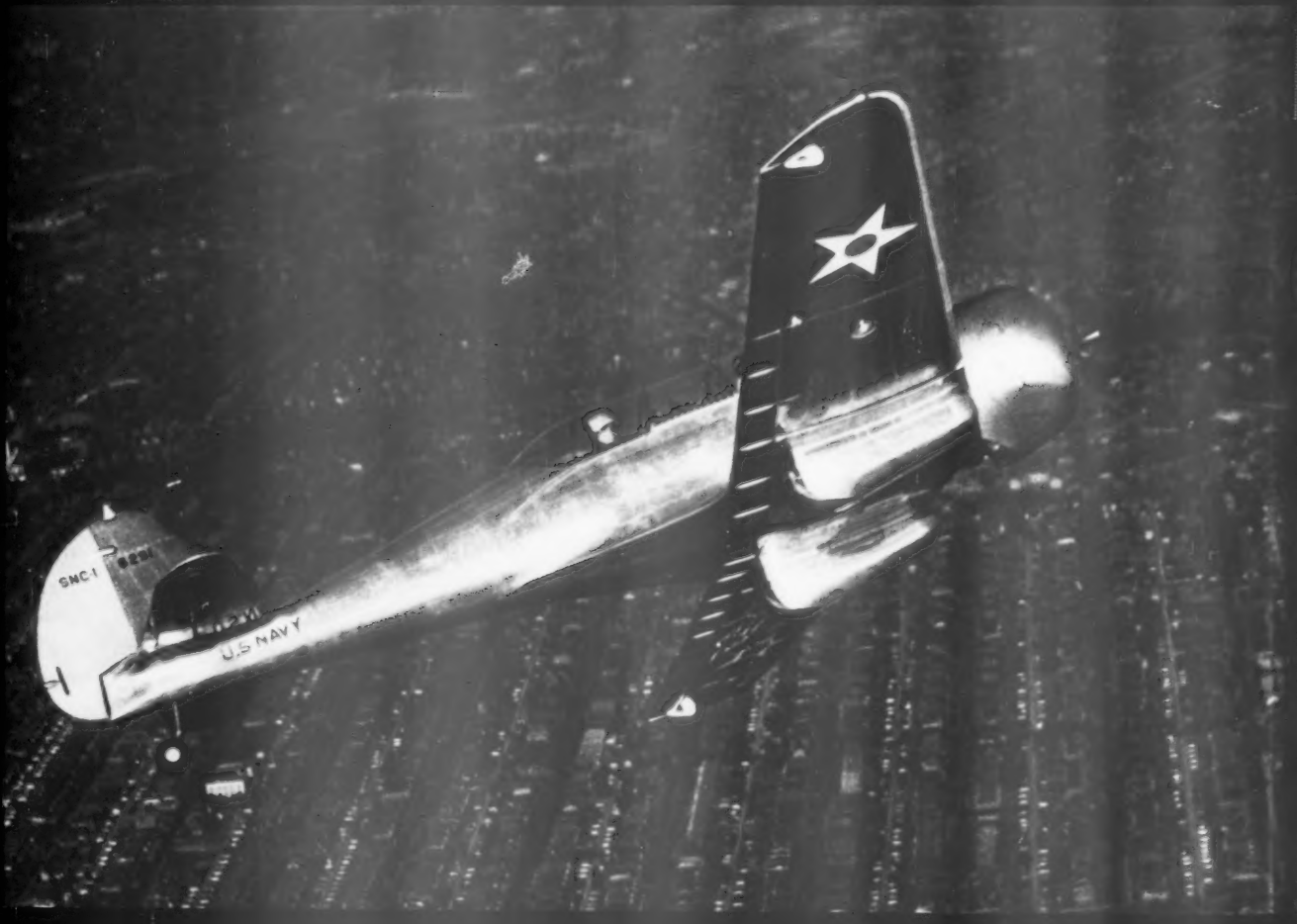


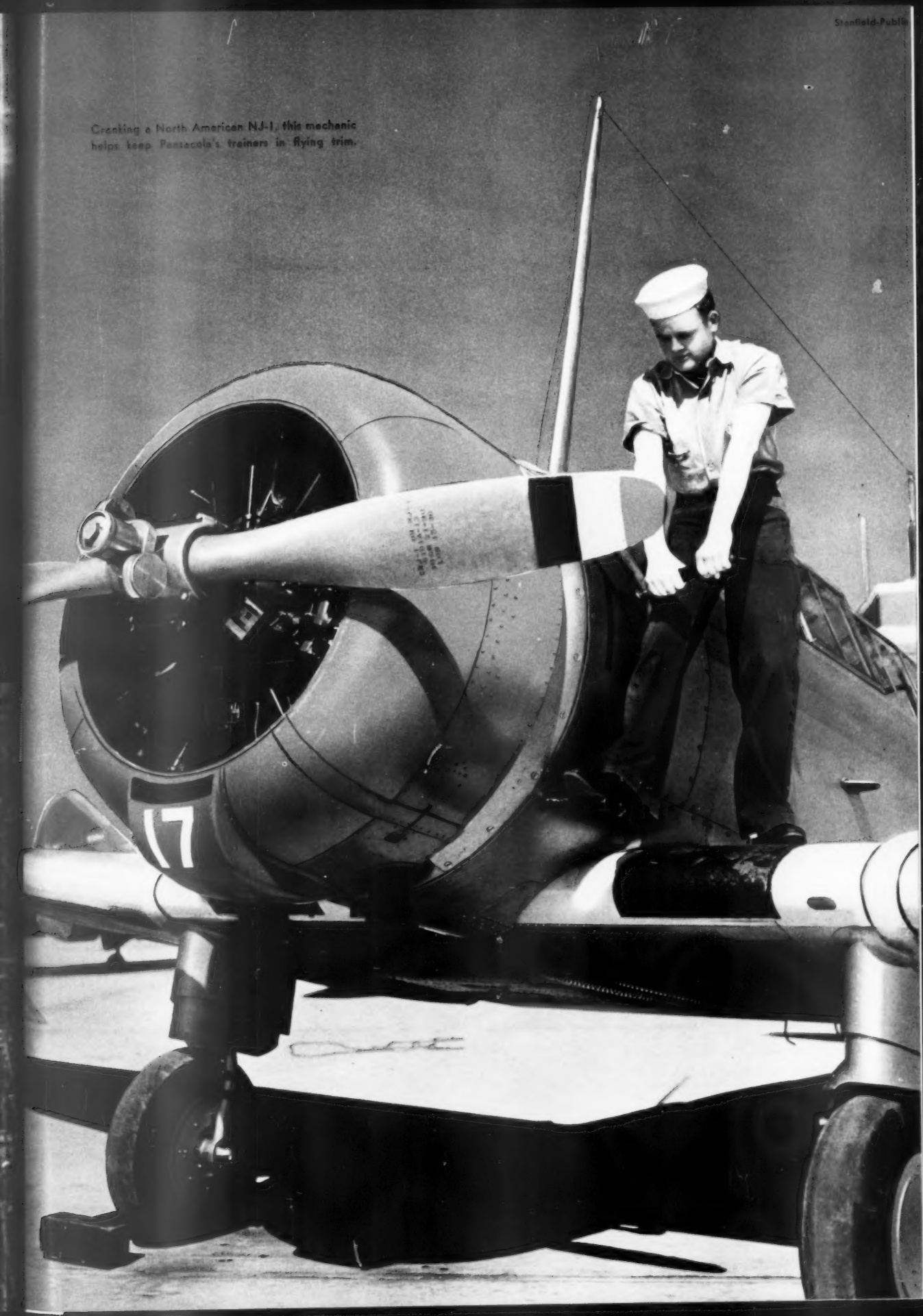
One of nation's most modern control towers is located at the Naval Air Station, Norfolk, Va.



Veteran primary trainer in the Navy is the N3N-3, designed and built by the Naval Aircraft Factory.

Latest Naval advanced trainer is the Curtiss SNC-1, a fast two-place monoplane with retractable wheels.





Cranking a North American NJ-1, this mechanic helps keep Pensacola's trainers in flying trim.

Stanfield-Public

Non-rigid L-1 is one of U. S. Navy's highly efficient lighter-than-air craft, stationed at Lakehurst, N. J.

Currently used for hauling everything from cargo to parachute troops is the Marines' Douglas R3D-2.

Rudy Arnold

Ulric Meisel

Ulric Meisel

Wash Day

An Atlantic-patrolling Consolidated "Catalina" (PBY-5) gets a routine bath between flights.

Beechcrafts for Defense

The Air Corps F-2 Photographic BEECHCRAFT shown above is one of a rapidly growing number of various types of BEECHCRAFTS serving the U. S. Army Air Corps and the Navy Bureau of Aeronautics. More than 90 million dollars worth of BEECHCRAFTS have been delivered to, or are under construction for the Army and Navy. In addition to the F-2 pictured, the various types include:

Navy Bureau of Aeronautics	JRB-1 special observation and utility transport
	JRB-2 personnel transport
	GB-2 light (single-engine biplane) personnel transport
U. S. Army Air Corps	C-45A personnel transport
	AT-7 advanced (long-range navigation) trainer
	AT-11 advanced (bombing and gunnery) trainer
	AT-10 transitional trainer

The entire resources of the Beech Aircraft Corporation, which currently include more than 670,000 square feet of modern production facilities, and 5,600 trained workers, are devoted 24 hours a day to the swift production of these BEECHCRAFTS for Defense.

LET'S GO! U.S.A. · KEEP 'EM FLYING!

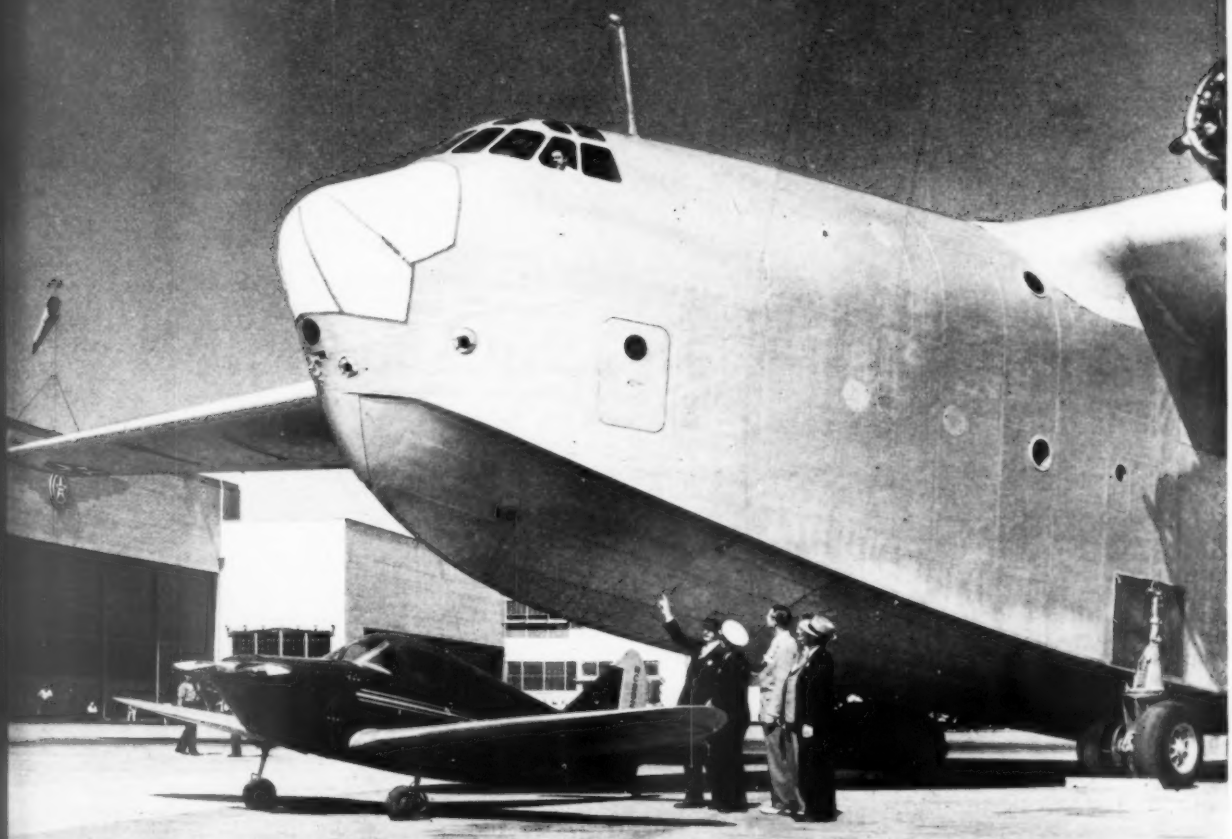
BEECH AIRCRAFT CORPORATION

Beechcraft

BEECH AIRPORT
WICHITA, KANSAS
U. S. A.

VPB

—The PATROL BOMBER



Sharp contrast to the Navy's huge new Martin "Mars" is a tiny Culver "Cadet" sport plane.

Principal function of these battleships of the air is to protect the United States fleet against surprise attack.

VPB—THE PATROL BOMBER

by Rear Adm. JOHN S. McCAIN

Commander of Aircraft Scouting Force, U. S. Fleet, Rear Admiral McCain was designated Naval Aviator in 1936, 30 years after his graduation from Naval Academy. Born in Teoc, Miss., August 9, 1884, he has spent many years in the Pacific, served on ill-fated U.S.S. Panay. Prior to his present post he served as the commanding officer, San Diego Naval Air Station.

A SPAN of 30 years, from the first seaplane flight, encompasses the life history of American VPB aviation.

The story of those 30 years is a diary of names, events and ideas, attempts and failures; but above all, a record of steady progress and achievement. It is fitting that the Navy from the outset should have fostered this development. Today, the universally acknowledged pre-eminence of Naval aviation is due in a large measure to the work of the patrol boat pioneers.

During this process of evolution technical advances in mechanical arts crowded so fast upon the heels of experiment that the terms "obsolete" and "obsolescent" applied to an aircraft before the paint was dry. Every phase of patrol plane aviation has been marked by compromise between what the aviators wanted and what the builders could give at the time.

A good design on paper might fold up completely when subjected to service tests. Expensive? Yes, but worth every dollar spent in the light of present needs for national defense. For there is not a major airplane or engine builder today whose growth is not associated with that of Naval aviation—and most of them with that of the patrol plane.

Early in the development of aviation Glenn H. Curtiss was impressed with the advantages of an airplane that could be operated from the water. About 1908 he conceived the general idea of the machine with which, on January 26, 1911, he made the first public seaplane flight in this country. This plane, of single float design with auxiliary wing tip floats combined with hydro surfaces, was powered with a 60 h.p. Curtiss motor. Within a year, the single float idea was temporarily abandoned by Curtiss for one with a pronounced boat shape—the forerunner of today's flying boat. From this point evolution was rapid. A single-engined plane with two propellers progressed to twin-engined planes with individual propellers, engines of increased power, enclosed fuselages, metal propellers and larger metal hulls.

By 1914, Rodman Wanamaker, a civilian flyer from Philadelphia, was planning a transatlantic flight in a Curtiss flying boat of 5,000 pounds gross weight. This plane, the *America*, with its 72 feet wing span and 300 gallon gasoline capacity, was powered by two 100 h.p. Curtiss engines. While this flight did not materialize, it indicates the extent of development of the "big boat" at this early date.

The year 1916 saw flying boats of three and even four motors. Development of the Sperry automatic pilot to alleviate the pilot fatigue resulting from increased ranges and endurance of even those days was well underway.

Upon the termination of World War I, lack of appropriations slowed up patrol plane development which had progressed to the NC multi-engined design. The construction of several of the NC design flying boats was carried through to completion in 1918 and these planes carried the torch in the first transatlantic flight in May, 1919. Up through 1925, the supply of wartime flying boats and Liberty engines was adequate to provide training in these types but, by 1926, this source of material was practically exhausted. Except in a very minor way, patrol plane operations with the Fleet practically ceased for a period of several years. Such operations as there were, however, were rugged indeed, necessitating living and eating aboard the planes, fueling from tenders or small boats, enduring heat and cold, rain and fog—but all in all forming a splendid background for the recrudescence which was to come.

In 1930, five years after the memorable transpacific flight of Commander Rodgers in a Navy-designed patrol plane (the PN-9), the flying boat once more came into its own. Progress in the metallurgical and engineering fields permitted the employment of higher powered air-cooled engines, metal propellers and duraluminum hulls.

The reviving influence of these scientific advancements enabled the VPB plane to develop rapidly into the multi-engined, streamlined monoplane of the present. Today's modern giants of the air are powered by two or four 1,200 to 2,000 h.p. air-cooled engines. Each power plant drives a three-bladed, 17-foot 6-inch diameter propeller of duraluminum, whose pitch can be varied at the will of the pilot, from the normal positive for high speed or climb in flight to reverse for backing purposes on the water.

A metal-clad hull and fuselage and glass enclosed cabins protect the crew from tropical heat at sea level and arctic cold at 25,000 feet. There are bunks in which members of the crew may rest or sleep while not on watch. Although a professional cook is not included in the flight crew, the amateur standing in cuisine of many of the mechanics is not beyond question. Midnight raids on the icebox are possible, but discretion there is the better part of valor. At advanced bases many of the crew prefer the comfort of the patrol plane to the crowded condition of the tender. Overnight flights from San Diego to Panama or Hawaii are now of routine nature.

The VPB type aircraft is designed primarily for long range, overseas scouting from shore bases or tenders. A multi-engined flying boat with accommodations for a crew of seven to 15, depending on its type, is capable of remaining in the air for relatively long periods regardless of the vagaries of weather. Besides being seaworthy, it is sufficiently habitable to permit operating singly for extended periods. As compensation for a speed performance that is, in general, inferior to that of other fighting aircraft, its armament design includes powerful defensive features. Offensively, the VPB plane is equipped to carry heavy loads of bombs, torpedoes and mines, with possibly some sacrifice in its fuel load, and hence in its range and endurance. In brief, the patrol plane is the dreadnaught of the Navy's air arm.

The long-range flying boat lends itself particularly to strategical considerations and is peculiarly adapted to the geography of our vital areas, both islandic and continental.

The broad mission of the VPB organization (Patrol Wings, U. S. Fleet) is to maintain itself in a state of readiness to operate at maximum effectiveness, with or in support of the Fleet, in all theaters of operations where patrol planes can be employed. Mobility, reliability and self-sufficiency are stressed. Specifically, the major task of VPB aircraft is "scouting" which, for the benefit of the uninitiated, is defined as "operations conducted to obtain information of the enemy." By their scouting for positive or negative information, these aircraft advance the visible horizon for the Fleet commander by hundreds of miles—distances equivalent to several days' steaming by high-speed surface craft. In this service of information for the Fleet, patrol planes are the long range "seeing eyes" of the Navy.

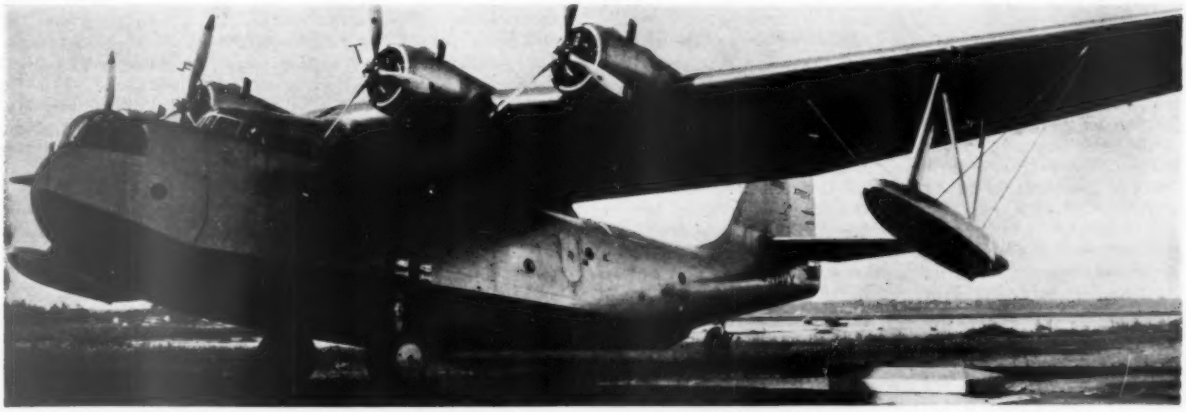
As stated previously, the primary function of VPB airplanes is long range scouting. This country is fortunate in being flanked by two oceans. Yet those vast bodies of water are at the same time the highways of our trade and the approach of any threat to our security. Therefore, control of vital and critical sea areas and the exercise of that control is necessary to that security. And this is a primary function of our Navy. The patrol plane has been designed to fit particularly into that picture. While it is expected that long range scouting will be the main employment of these aircraft, it is by no means their only function.

These planes are formidable bombers and are excellent tor-

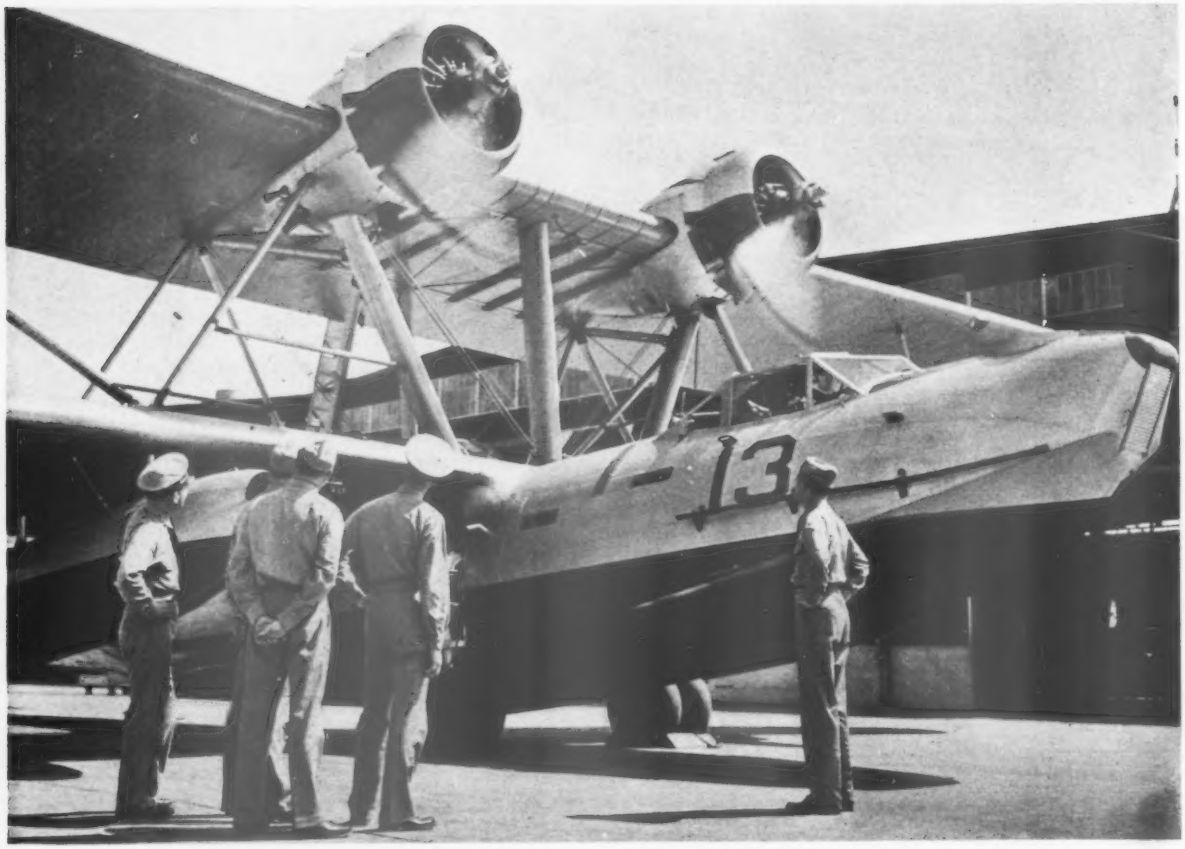
Famed for exploits like interception of Bismarck is Consolidated "Catalina," used by U. S., Dutch and RAF.

Now on patrol beside "Catalinas" are newer Martin "Mariners." Note its size beside Aeronca lightplane.

The Navy now uses many giant four-engined Consolidated "Coronado" (PB2Y-2) patrol bombers like this.



Vought-Sikorsky XPBS-1 was experimental patrol bomber, still is used by the Navy for transport and research.



Predecessor of Consolidated's famed "Catalina" (PBY) was the P2Y-2. Many of these veteran but obsolete patrol bombers still are flying, but mostly as miscellaneous utility craft and training planes at Pensacola.

pedo carriers. They are available and adapted for long range photographic reconnaissance and the larger type are perfectly capable of transporting troops in considerable number should that contingency arise. The British are now using Consolidated *Catalinas* on escort duty for their convoys approaching the British Isles and we would undoubtedly employ similar airplanes in the same duty under like circumstances.

In fulfilling these functions, VPB planes are designed for maximizing self-sufficiency. They may operate from large prepared bases, as exemplified by our major Naval air stations, or from advance bases which have been especially prepared to accommodate them such as those built or building in the outlying Pacific Islands and in those British possessions in the East acquired through the "destroyer transfer." Again they may operate from still farther advanced bases at which there are no preparations at all, sustained by mobile tenders which have been designed and provided for this particular purpose. The tenders provide the "mobility" of the patrol plane organization and extend tremendously the usefulness of the planes employed. In fact, their strategic offensive utility, that capacity for ready dispersion of squadrons of VPB airplanes to form self-sustaining units in out-of-the-way corners of the earth, is the keystone of their effectiveness.

Advanced base operations frequently call for the utmost judgment and nicety in airmanship and in seamanship. All of the pilot's powers of observation must be called into play as he estimates the situation. Where is the wind? Are there any swells running? What is the character of the bottom? Are the coral heads visible? Is there a clear channel to the beach? Can a take-off be made in the small lagoon? Where is the tender anchorage?

These questions and many more race across his mind before he decides to bring the plane in for a landing. It is the best training in the world. Being able to fly well is only the beginning of the patrol plane pilot's career. Then comes seasoning through experience. There is no short cut to this goal.

A good working knowledge of seamanship is a prime requisite for patrol plane pilots. Proficiency in bringing a patrol plane gently alongside a ramp or neatly to the buoy is acquired only by practice under all conditions. The wind is seldom in the right quarter to permit a straight up wind approach, nor is there usually a large space available in which to maneuver, in case the first attempt goes sour.

There is hardly a more hopeless or helpless feeling than to be sitting in the pilot's seat with your plane headed for the corner of a dock and both engines dead. The tail surfaces crumple so easily and that glass nose makes a pretty poor fender. Furthermore the commander will have some uncomplimentary things to say. The cautious pilot will sometimes stop well clear and signal for a boat. Some aces regard this as akin to eating humble pie. It is not a sign of inaptitude, however, to call for the assistance of a boat when conditions warrant.

Fueling operations are conducted from gas trucks at regular bases; at advanced bases from the tenders, or at the mooring buoy from gas boats. The fueling of 12 modern patrol planes is a task in itself, with each plane slaking its thirst to the extent of many hundreds of gallons.

We now pass from the structural and handling characteristics of the VPB plane to its position within the Fleet.

The organization within the flying boat may be divided into two groups—piloting and non-piloting personnel. In the smaller VPB's, we find three pilots; two of them are officers and the third an experienced enlisted pilot. Not included in this roll call is "Iron Mike," the automatic pilot who does not differentiate between sunny skies and zero zero conditions. With the exception of navigation duties, which are handled by one of the officer pilots, all three are trained to perform the same function in an equally effective and smooth manner.

The patrol plane organization is the only branch of the Naval

air arm that rates its pilots according to experience and ability. The new pilot joins the crew as a second pilot. As his training advances he becomes a first pilot then, after hundreds of hours of indoctrination and training, he earns the official designation of "Patrol Plane Commander."

In the non-piloting group of the crew are the mechanics and the radio operators, who perform essential engineering and communication duties. When the situation demands it, all members of the crew man stations for offense or defense—bombing and torpedo gear and machine guns. All in all, the patrol plane crew is a highly trained unit, whose teamwork, co-operation, intelligence and morale are and must be of the highest order.

There was a time not too long ago when patrol plane pilots were known as the "truck drivers" of aviation. The planes were cumbersome, heavy and actually were about as sensitive to the controls as the average truck. Range limitations were such that few really long flights could be made because of the logistic problems involved. Those that were attempted were punctuated by frequent stops. Except for a few isolated distance record attempts in specially prepared planes, transocean flying still was a future objective.

Small wonder the newly graduated pilot felt that he was condemned to the Old Pilot's Home if he drew an assignment to a patrol squadron, while his contemporaries were testing their newly acquired wings in aircraft carrier squadrons. Everybody felt that fighter pilots were the cream that is skimmed from the top of each class and that a special recommendation was required for those choice billets. Anybody could fly one of those big crocks in the VP squadrons—that is, provided he could get it off the water.

The evolution of the modern patrol bomber has been a gradual procedure, but it has far surpassed the development of other types. Perhaps it was so far behind its rivals that it *had* to go faster to catch up. Neverthless it *has* caught, if not surpassed them. Your modern patrol plane has none of the "built-in head wind" of its predecessor. Its cruising speed now compares favorably with the fastest carrier types and in range it has left all other types far behind. Transoceanic and non-stop flights of well over 3,000 miles now are commonplace. Navigation is a major problem and a far more difficult one than that which faces the navigator of a surface ship, due to the relative speeds entailed and to the lack of information on wind drift, as compared to surface currents. The modern patrol plane is a command of which any junior officer may well be proud. It demands more varied ability, intelligence, ingenuity and resource of its commander than any other type.

Patrol planes are organized into squadrons—normally of 12 planes—and into wings, generally of four squadrons. To each wing is further assigned a number of tenders. For operational purposes, the wings in each fleet are grouped into a single command which functions directly under a major force or fleet commander. In administration, the entire group of wings in the two major fleets is organized into a "type" command, known as Patrol Wings, U. S. Fleet.

Information is without doubt the most important service required by a fleet commander. Accurate, complete and up to the minute knowledge of the position, strength and movement of enemy forces is very difficult to obtain under war conditions. If these facts are made available while the enemy is at a great distance from our shores and similar information about our own forces is denied the enemy, the commander is given time to plan his movements and select the time and position of contact in such a manner that he may operate under a tactical advantage. In other words, in the vernacular of the sports world, he can make his own breaks.

For the source of this most important information, the fleet commanders have come to rely more and more on the patrol plane. With their normal and advance bases strategically located, surprise contacts between major forces can hardly occur. In addition to receiving contact reports on enemy forces in these vital areas the patrol planes, due to their great endurance, can shadow and track these forces, keeping the fleet commander informed of their every movement.

Readers of current events are familiar with the publicized exploits of the successful search by an American-built patrol plane (similar to the Navy's PBY-4 type) for the new German superbattleship *Bismarck* and her subsequent destruction, and also the success of a second similar patrol plane which, unaided, caused the surrender of a German submarine on the high seas. Another example of the routine type of service not in line with normal military flying which the patrol plane performs is afforded by the following account:

An auxiliary ship of the U. S. Navy, proceeding from San Francisco to the Philippines, was passing about 1,500 miles northeast of the Hawaiian Islands, when the sole medical officer aboard suddenly was stricken with acute appendicitis. With the assistance of a chief pharmacist's mate all possible measures were taken to prevent rupture of the appendix prior to an emergency operation.

A patrol plane was dispatched from the base at Honolulu with a Navy surgeon aboard. En route and upon arrival at the auxiliary vessel, the pilot found that prevailing northeasterly winds were kicking up heavy seas. There was a slim chance of landing the plane safely and of transferring the doctor to the ship. There was no chance at all for taking off in the mountainous seas for the return flight to Honolulu. With a life at stake, there was no delay in the pilot's decision to accept what damage might result in the landing. After a few bounces, to which the descriptive term "graceful" could not be applied, the plane came to a stop without serious mishap.

The medical officer was transferred to the ship and a suc-

PATROL BOMBERS 1930-35

The Martin PM-1, vintage of 1930, had two 525 h.p. "Cyclones." Top speed was 120 m.p.h., range 1,200 miles.

An early type Keystone PK-1 two-engined flying boat. Unlike in today's craft, crew had to sit in open cockpits.

Martin biplane patrol bomber of 1935. Notable features were engine ring cowlings and three-bladed propellers.

Compact but highly efficient, cockpit layout of patrol bomber follows style set by clippers. This is forward view in "Mariner."

Looking toward rear of VP-56 "Mariner." Crew members always wear inflatable jackets and parachute harness while plane is in air.

cessful appendectomy was performed which, without doubt, saved the life of his professional brother. Two days later, a Navy tug from Honolulu picked up the plane, slightly in need of treatment itself as was the operating physician. The auxiliary ship resumed her passage with her patient aboard recuperating normally, thus ending a happy story.

Incidents such as this are legion in the colorful annals of patrol plane history. They serve to emphasize the importance of this versatile "infant" of Naval aviation.

In this article we have attempted to hit upon the salient points relative to the part played by the VPB plane in the operation of the United States Navy. Of necessity it has been a story without an ending. Only the future can unfold this, but past and present performances give rise to a logical assumption—that the "flying boat" will ever be in the fore as this country's actual "first line of defense!"

Editor's Note—As pointed out in this article, fundamentally the hull forms of today's flying boats are the result of model basin experiments inaugurated by the U. S. Navy in 1911.

After the flight of the first Curtiss hydroplane, it was decided that the position of pilot and motor between the wings could be improved upon. Curtiss lowered both to the pontoon and the idea of a flying boat was born. The craft, known as Flying Boat Number One, was given its first trial flight in January, 1912. This plane was powered with a 60 h.p. motor turning two tractor propellers through a chain system. In cleaning up the design of this craft, Flying Boat Number Two was produced, with motor between the wings and a pusher propeller. The pilot was placed in a cockpit near the bow. The hull was extended to carry the tail surfaces.

The following year, 1913, the Navy conducted many experiments with both seaplanes and hydroplanes. The Wrights, Starling Burgess, Aeromarine, Martin, Standard and several others entered the flying boat and seaplane field of experimentation and production.

With the sponsorship of Rodman Wanamaker and the collaboration of Glenn Curtiss and the Navy, the flying boat *America*, designed for transatlantic flight, was produced. She had a wing span of 72 feet, and was powered by two OXX engines. Naval observers witnessed the trials and assisted in the modifications ultimately incorporated in this hull. These modifications, briefly, composed: a large increase in beam forward of the step which introduced the sponsons found later in the F-5-L, H-16, HS, and H-12. The bottom was full-rounded to the step, which extended in a reverse curve to the chines. The latter feature was to be found later in both the H-12 and HS types.

From this flying boat, the British developed the deep "V" bottom, although the U. S. Navy had tested such a design in floats in 1912 at San Diego. These English types became the prototypes of the H-16 and F-5-L used successfully by the U. S. Navy during the World War. Meanwhile Curtiss developed the H-12 and the HS hulls, which had a broad reversed curve bottom terminating in a streamlined margin at the step.

The HS boat was produced in large quantities and many were utilized in submarine patrol services in European waters. Following the War, the HS's, H-16's, and F-5-L's were released to commercial interests and placed in operation in the southern United States and Caribbean waters, forming a background for commercial development.

The H-16 was originally the Felixstowe design and many of these were constructed prior to our entry into the World War. The British plane used two Rolls Royce engines of about 250 h.p. each. These hulls were provided with a deep "V" main step and a secondary step at about one-third the distance from the main step to the stern of the hull. The wing span was 95 feet. In the United States this design was fitted with two Liberty engines. The maximum load was 10,900 pounds.

The Navy's F-5-L, an outgrowth of the British F5A, was substantially an enlarged H-16 providing greater range and ordnance load.

The test of the first transatlantic flight indicated that the hulls of the NC's required more buoyancy at the stern. Based on model basin research a new set of lines was evolved known as design Number 71, and a "type design" was issued for a monoplane type flying boat utilizing these lines, essentially the NC lines of hull with an integral extension which carried the tail surfaces.

The next development was the PN type, designed and built at the Naval Aircraft Factory, Philadelphia. The success of this boat was demonstrated when Comdr. John Rodgers flew the PN-9 from San Francisco to within a few miles of Honolulu in September, 1925.

The last few years have brought outstanding contributions by various manufacturers to the development of flying boat construction. This is evidenced by the present day operation of these planes in commercial service and the outstanding records held by the Navy's patrol planes in flights involving distances of several thousand miles of non-stop flight.

END

VF—The FIGHTER

An aerial attack on the U. S. Navy would be possible only after enemy forces defeated our tough, powerful and heavily-armed fighters.

Grumman "Wildcats" being refueled.

VF —THE FIGHTER

by Lieut. Comm.
JOHN B. PEARSON, JR.

Well qualified for his present duty in charge of fighter design section, Bureau of Aeronautics, is Lieutenant Commander Pearson. Born in Waukesha, Wis., January 30, 1902, he was graduated from Naval Academy in 1923, returned there for postgraduate work in aeronautical engineering, completed course at M.I.T. in 1928. He was designated a Naval Aviator in 1932 at Pensacola, Fla.

IF there is one lesson which stands out above others in the current war it is the need for a large proportion of fighters in any well-balanced air force. The thrilling accounts of a handful of British fighters attacking without hesitation and breaking up large formations of enemy bombers serve to strengthen the Navy's conviction that in the fighting plane lies its first line of aerial defense. As a result, the percentage of fighters on carriers has been increased, a large number of reserve fighter squadrons are being organized and the combat qualities of the planes themselves have been vastly improved.

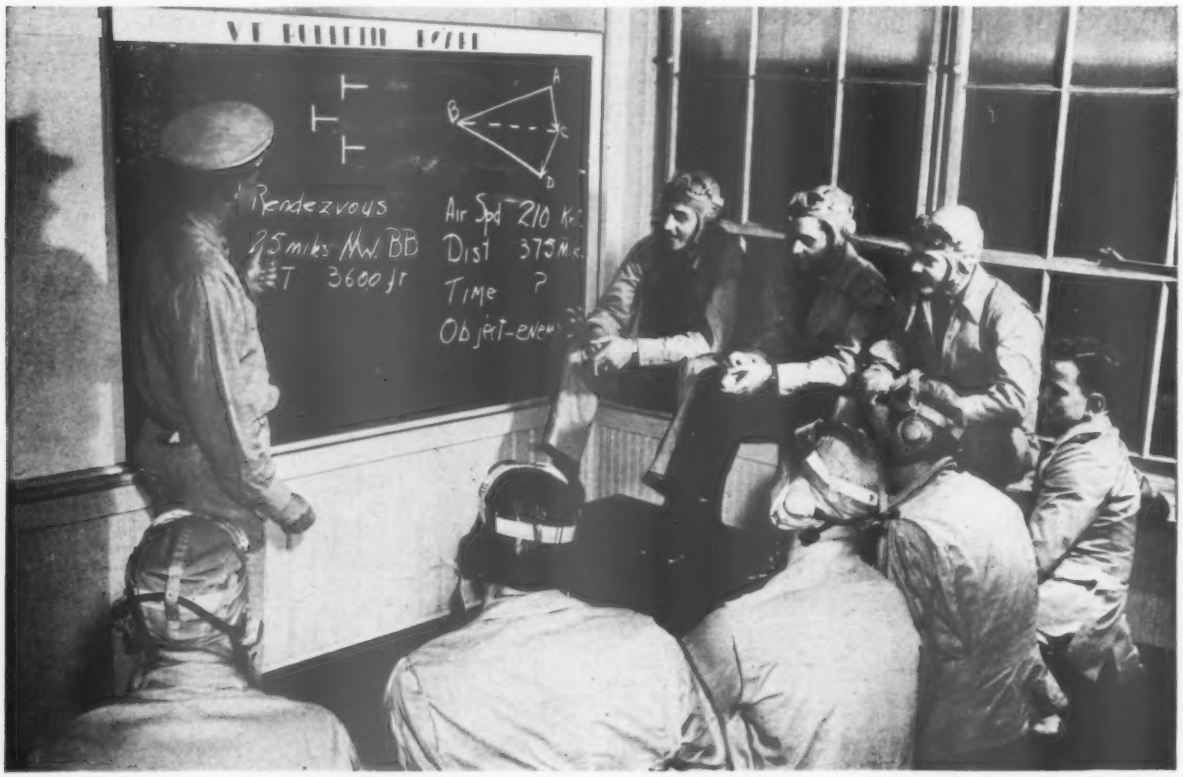
It is interesting to trace briefly the history of the Navy's fighters. During the World War era, they were launched from platforms built on the turrets of our battleships. There was no provision for getting back to the ship once the plane was launched and the pilot had to land ashore, if he could get there, or otherwise ignominiously plop into the water when his gas ran out. The *Hanriot* is representative of the fighter of that day. It had a high speed of 113 m.p.h., landed at about 45 m.p.h., and carried two fixed 30 caliber guns. The battleship headed into the wind, the pilot said a little prayer, turned up the engine and rumbled off the end of the platform, hoping to get his flying speed before he hit the water. The airplane and its rickety gear were considered a nuisance by the average battleship skipper, who missed no opportunity to leave it ashore when its presence might interfere with the seagoing function of the battleship. As there was no opposing voice in Naval aviation, this lack of interest harmed nothing but the feelings of the aviators concerned.

Following this beginning was a period of testing fighters on floats and catapulting them from battleships. The TS-1 was a good example of this type. It had a top speed of 123 m.p.h. and landing speed of 50 m.p.h. The armament consisted of two 30 caliber fixed guns. These airplanes were useful, but difficult to land successfully at sea and were limited in number to the two or three that could be carried on a battleship. This basic design was changed from twin floats to a single float and developed into our present observation type. The fighter function was taken over by the newly available types on wheels.

These latter were afforded a landing field afloat when the *Jupiter*, an old collier, or coal carrying vessel, was given a flight deck and renamed the *Langley*. The use of arresting gear made it possible to land airplanes on, as well as fly them off, the ship. Typical of the fighters used in 1922 to 1924 on the *Langley* is the VE-7, which had a top speed of 116 m.p.h. and a stalling speed of about 52 m.p.h. It had two fixed 30 caliber machine guns firing forward.

With the two big carriers *Lexington* and *Saratoga* joining the Fleet in 1928, really substantial numbers of fighters were available for the first time. Each carrier operated 36 fighters in addition to its scout and observation planes. Typical of fighters that were first operated on these ships were the liquid-

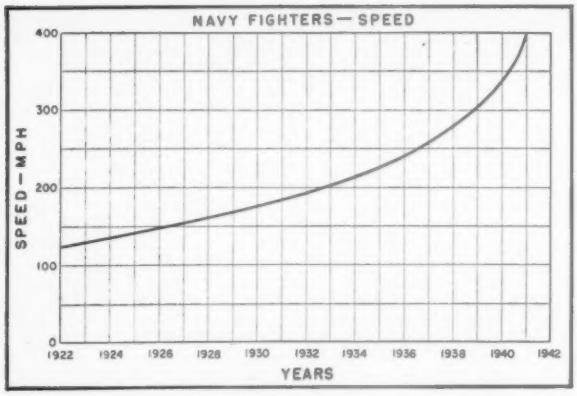
Navy pilots receive instructions preparatory to a practice attack on battleship (BB). Their plan: fly given course at 210 knots (243 m.p.h.) for 375 miles, circle 25 miles from target at 3,600 feet until attack order is given.



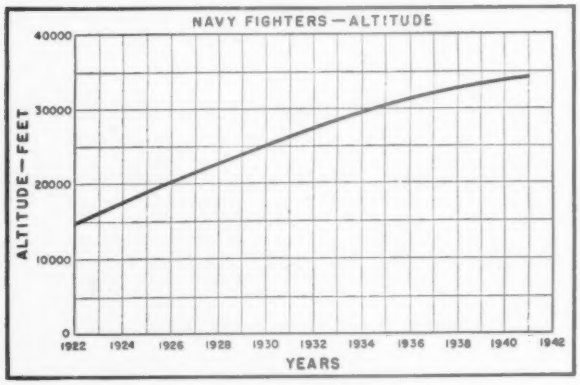
Standard single-engined fighter is Grumman "Wildcat" (F4F). Its 1,200 h.p. Pratt & Whitney engine gives it a reported top speed of 350 m.p.h. Latest version has armor and leakproof tanks. Weight: 6,100 pounds.

Brewster "Buffalo" (F2A), another Navy fighter, is a favorite with the British Fleet Air Arm and the Netherlands Indies air force. The Finns got 43 in last fight with Russia. Engine is 950 h.p. Wright.

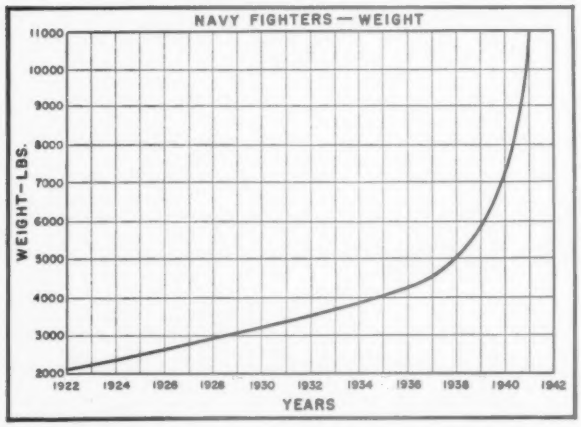
A favorite with Navy and Marine pilots was the Grumman F3F series, now being replaced with "Wildcats." Performance is reported to include a 270 m.p.h. top speed, climb of 3,000 f.p.m. Its ceiling is 32,000 feet.



Speed of Navy fighters has been increased by 100 m.p.h. in last two years. Much is due to big increases in horsepower.



To combat high altitude bombers, fighters now have increased ceilings. Progress lags here because of technical difficulties.



Sharply increased weights is due mainly to bigger engines, armor and armament. Weights climbed two tons in one year.

cooled Curtiss *Hawks* (F6C-1) whose 410 h.p. engine gave it a speed of 155 m.p.h. It had 3 hrs. 18 mins. gasoline and carried two fixed 30 caliber machine guns. This type still is considered by pilots who flew them as one of the sweetest handling of all the Navy fighters. The airplane was issued to the service with no restrictions as to diving or engine speeds. One of our pilots who operated the plane tells of standing it on its nose for 15,000 ft. with engine turning up 3,400 r.p.m. and wires screaming and finally pulling out practically on the roof tops. He tells you in the next breath that he gets an extra grey hair every time he thinks about it now.

Due to the disadvantage, inherent in all liquid-cooled engines, of complete power plant failure incident to a small hole in the cooling system, the Navy instituted the development of the air-cooled engine. This led to the F2B, F3B and F4B Boeing fighters, which were all powered by *Wasp* engines, the last modification of which was rated at 550 h.p. The F4B-4, which was brought out in 1932, had a top speed of 188 m.p.h., a stalling speed of 63 m.p.h. and carried 3 hrs. 6 mins. of gasoline. Like its predecessors it carried two 30 caliber fixed machine guns, although provisions were made to substitute a .50 caliber gun for one of the .30 caliber as an alternate load.

About this time the Navy tried out the two-seater fighter in the form of the Grumman FF-2. Due to its retractable landing gear and 600 h.p. engine, it was able to compete very favorably with the single-seat fighters of its day. When the latter were given the equivalent power and aerodynamic refinement, however, they developed a substantial speed differential which was enough to eliminate temporarily the second seat from the carrier fighter type in spite of the protection afforded by the rear gunner.

The Boeing line of fighters was replaced by the Grumman, the first of which were biplanes. These series gained their advantage over the F4B's from improved engine cowling, increased horsepower and retractable landing gear. They started with the F2F-1, which had a top speed of 228 m.p.h., a stalling speed of 66 m.p.h. and seven hours of gasoline at cruising speed. It carried two .30 caliber fixed machine guns like most of its predecessors and was an outstanding performer in its day.

The Grumman series of biplanes was replaced by the Brewster and Grumman monoplanes which have recently been named the *Buffalo* and *Wildcat* respectively. The first *Buffaloes* were called the F2A's and were without armor and leak-proof tanks which have been found so necessary in the present war. Both types now are used in the Fleet in substantial quantities and are being delivered in large scale production with the protective items installed. They have a volume of fire which in hitting power is approximately 100 per cent greater than the eight-gun batteries of the British *Spitfire* and *Hurricane* types. The top speed of the *Buffalo* and *Wildcat* is substantially over 300 m.p.h. The Vought-Sikorsky F4U-1, recently dubbed the *Corsair*, is to be the latest addition to our stable of Fleet fighters. The experimental airplane has been clocked at over 400 m.p.h. and a large production order for the airplanes is well under way. Needless to say, it has offensive and defensive characteristics which are thoroughly modern.

In order to obtain the maximum usefulness from our somewhat limited numbers of airplanes the F6C-1's were given a secondary function as dive bombers as early as 1926. They carried 30 lb. bombs and were the forerunners of the present day highly developed dive bombers. The size of the bombs was increased to 100 pounds on the Boeing fighters and to 500 pounds on the Curtiss dive bomber fighters. This latter turned out to be too much of a handicap to a fighter due to the gear necessary to displace the bomb clear of the propeller and to the extra strength required. Subsequently the bomb loads carried by fighters have been substantially reduced.

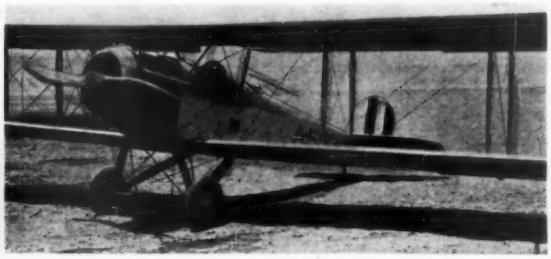
No article about Navy fighters would be complete without a word about the men who fly them. A halo of hero worship, richly deserved, was built up around the personnel of the early fighter squadrons. They were hand-picked pilots whose flying ability, always superb, was exceeded only by their enthusiasm for the work. Out of this group came the several well known stunt teams which thrilled the stands at air meets in the late 20's and early 30's. Perhaps the best known of these was made up of Tomlinson, Storrs and Davis of old "Fighting Six" whose precision and daring elicited alternate gasps and shouts of admiration from expert pilot and schoolboy alike.

Stunt flying is only a minor part of the duties of a fighter pilot, however, and is encouraged principally to train the pilots in their more important work of getting a plane into position to hit the other fellow before he hits them. Long hours have always been spent in training for combat by engaging in dog fights using a camera instead of a gun and in firing at towed sleeve targets with fixed machine guns.

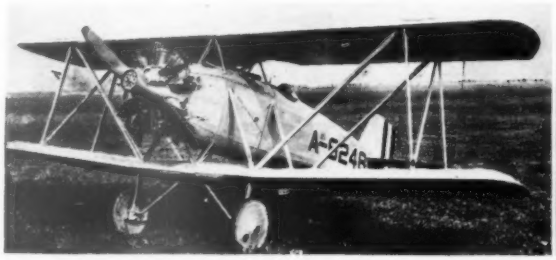
The chief interest of the fighting squadron is their gunnery

CHRONOLOGY OF FIGHTERS 1919-1939

One of the first Navy fighters was this World War Hanriot biplane, powered with a rotary engine. Made of wood, with fabric covering, it carried some of the first air-cooled guns.



Originally designed as a carrier fighter, this Vought VE-7 was used in 1920 as a scout-observation type, was catapulted from battleships. Its armament was two guns.



First single-seater fighter built to Navy specifications was Curtiss TS-1. It was equipped with floats and used on battleships. Its design led to present observation types.

Predecessor of many subsequently famous Curtiss "Hawks," the F6C-1 was a 1928 carrier-based fighter. Most of today's dive bombing techniques were worked out with this plane.

Curtiss F7C-1, adapted from an observation plane design, served as a Navy and Marine fighter. An early "Hawk," it was one of a long line of Curtiss fighters with that name.

Following the basic F6C theme, a newer carrier fighter was the Curtiss F11C-2, powered with 750 h.p. "Cyclone." Its top speed at sea level was 193 m.p.h., range was 570 miles.

One of the Navy's most famous fighters was the Boeing F4B-4, a type so well-liked that many still are used as trainers. They did dive-bombing with 100 lb. bombs.

One of the Navy's first two-place fighters was Grumman's FF-2, a model only recently outdated. It had retractable gear and enclosed cockpits. Grumman SF scout was similar.

score. The practices which they fire are very carefully selected to train pilots to hit a target from all angles and approaches. In spite of the explicit detailed rules laid out for these exercises, it is no uncommon sight to see a gunnery officer of a squadron pleading his case for borderline hits before the officially designated umpire in a manner that would do justice to a famous criminal lawyer. To win the highly competitive gunnery competition is the ambition of every fighting squadron and you may be sure that the squadron that wins it represent a combination of flying technique and gunnery skill that is hard to conceive unless you see them in action. Nor is this high standard of excellence confined to the winner. The spirit of competition for the top spot pervades all the squadrons and results in a group efficiency which is believed to be the equal of any in the world.

A question which is so often asked is: "How much of a handicap must the fighter take in order to enable it to operate from the carrier?" To answer this we must outline the main differences between shore-based and carrier fighters. We are required to have arresting hooks to engage the wires on the carrier and catapult fittings to permit accelerated take-offs. In an effort to operate the maximum number of fighters from a given section of carrier deck, the wings of the newer types are designed to fold. In order to carry out Naval missions and still get back to the ship, the gasoline capacity is roughly 50 to 75 per cent greater than that of contemporary land-based fighters. This latter results in a small performance handicap but gives a compensating tactical and operational flexibility which is being duplicated in certain types of land-based fighters here and abroad. Our radios must be more powerful than those designed for use on land-based fighters and this calls for larger antennas with the attendant increase in drag.

The carrier fighter is usually "spotted" first on the carrier deck which means that it should have a take-off run as short as possible. This, in turn, necessitates special types of wing flaps or alternately larger wings with their higher drag and extra weight. The strength of Navy fighters, both for flight and landing condition, is considerably higher than other fighters in order to take care of the larger loads incident to dive bombing and to landing on the carrier deck when the latter is rolling and pitching.

The combined effect of all of these requirements results in an appreciable handicap to the carrier fighter which calls for extreme care in detailed design. It is a tribute to our airplane manufacturers and to the Naval air organization that the modern Naval fighter compares favorably with any equivalent type now used in shore based air services.

The mission of Navy fighters is essentially the same as that of land-based counterparts, viz: to maintain local mastery of the air. There was a time when most air strategists were singing the death knell of fighters due to the higher speeds of modern bombers. The same air strategists eliminated dog fighting because of the higher relative speeds. It is interesting to note that, on the contrary, the current war has emphasized the need for a still greater percentage of fighters to bombers in order to provide the stepped up two layer coverage now being required for daylight operations against a well equipped opponent.

Furthermore, if we are to believe the reports we read, a large percentage of engagements in which fighters are involved eventually turn into dog fighting melees. This is particularly true where one group of fighters is protecting a bomber group which the others are trying to destroy. The speeds and altitudes have changed but the tactics have remained essentially the same. Each group attempts to get the altitude advantage over the other prior to engagement and to exploit the element of surprise. The two plane section is becoming popular as the basic combat group in war operations. This is almost small enough to handle as one airplane and yet it provides for mutual assistance in a fighter action and divided simultaneous attack on bombers.

Each pilot uses that characteristic of his airplane which is known to be superior to that of his opponent. Due to the lower wing loading and superior maneuverability of the British *Spitfire*, the German Messerschmitt Me-109E does not dare stay in for a close fight against one but makes one quick diving attack, goes on past and climbs rapidly to altitude again. The *Spitfire* on the other hand stays clear of the Messerschmitt at altitude due to the higher power rating of the latter's engine and hence better climb.

The goal which all fighter designers strive to attain is enough speed so that no enemy fighter can dive away; enough power carried to such an altitude that it cannot be out-climbed; a low enough wing loading (or its equivalent) to prevent being out-turned; and enough maneuverability to prevent being shaken off by a quick change of direction. All this should come with enough gun power to knock down

(*Continued on page* 218)

Indications of what Naval aviation engineers have in mind for future fighters are the twin-engined Grumman XF5F-1 (left) and Vought-Sikorsky "Corsair" (F4U), now in production.

VT —The TORPEDO PLANE

If any airplane has revolutionized naval warfare, it is the torpedo plane. The U. S. Navy developed this deadly aerial weapon.

Current Navy torpedo bomber is the Douglas "Devastator."

VT—THE TORPEDO PLANE

by Lieut. Comm. STEADMAN TELLER

Formerly in command of a *U.S.S. Lexington* torpedo squadron, Lieutenant Commander Teller was a close observer of aircraft torpedo tactics under battle conditions during four months recently spent with British carriers in the Mediterranean, as assistant Naval attache for air at London. He was born in Kingston, N. Y., and was graduated from the Naval Academy in 1924.

Douglas "Devastator" (TBD), only torpedo bomber in Navy today, can carry bombs as well as a torpedo.

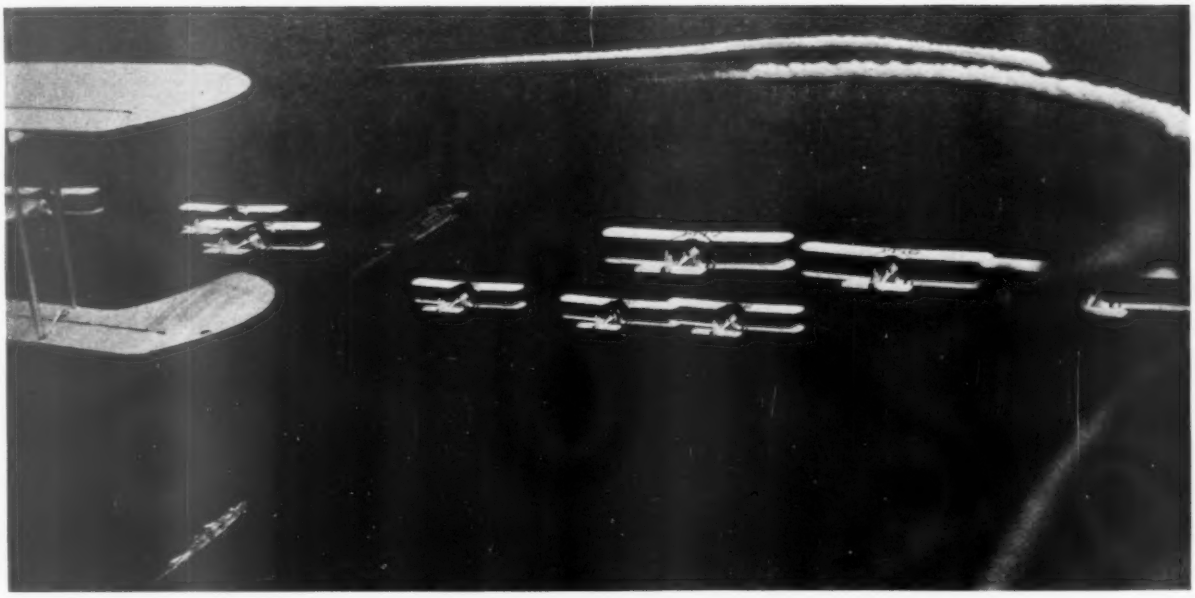
THE tremendous organized force that is modern war is providing the supreme test of military aircraft. In the pre-blitz days of undeclared war, the world watched two theaters of action where campaigns took drafting board theory and gave it the combat test. Out of the civil war in Spain and from Japan's persistent onslaughts in China, emerged an axiom that was to become an established fact. These two military operations alone established the fact that the fighter and dive bomber are essential to successful land fighting. Wherever they were used the high altitude bomber and the low-flying attack plane had spread destruction.

Until one night in November, 1939, the torpedo plane had achieved no such spectacular success. Then at Taranto, Italy, torpedo planes of the British Fleet Air Arm, launched from carriers that had eluded the Italian fleet and shore defense aircraft, appeared suddenly in the midst of a night bombing attack on that strongly defended Italian base. These planes wreaked havoc with naval craft at anchor in the harbor. Several ships were sunk outright and at least two capital ships were put out of commission for months. The British lost only a few planes.

This action brought to the attention of the world the facts concerning the accomplishments of torpedo planes operating in the Mediterranean. This was the beginning of a long series of aircraft torpedo attacks that were to affect profoundly the war on the sea.

The night action of the battle of Cape Matapan, to cite one of the more spectacular successes, was brought about by successful aircraft torpedo attacks on the Italian battleship *Veneto Vittorio*. Continuous daylight and dusk attacks by carrier-based torpedo squadrons reduced the superior speed of this modern battleship from a safe lead of 100 miles at noon to 30 or 40 miles at dusk.

During the night melee that followed, the Italians lost four cruisers and several destroyers from the forces that had been sent back to protect the crippled battleship. The British lost just one torpedo plane due to enemy action, in spite of the terrific antiaircraft fire that met each attack. My conversations with pilots of the attack groups upon their return to the carrier, and observation of the dusk attack antiaircraft barrage, confirmed this remarkable performance of unsupported aircraft attack against modern surface vessels.



Forerunner of the modern torpedo plane was Martin T4M, standard in 1928. Advance planes ahead lay smoke screen around target to shield low-flying torpedo planes against enemy antiaircraft fire.

The German battleship *Bismarck*, admitted to be the equal of any fighting ship in the world, was crippled by an aircraft torpedo after days of pursuit that almost ended in failure for the British navy. Again it was torpedo planes that attacked, with no support except favorable weather. Again the loss of British planes was insignificant in comparison with the results achieved.

Many other recent but less spectacular attacks have produced substantial results in the continuous campaign for control of the sea. The Red Sea was cleared of Italian destroyers with the help of the torpedo plane. Frequent night attacks against shipping in Albanian harbors cost the Italians many valuable cargoes. Shipping lanes between Italy and North Africa are under constant attack and Nazi shipping along the northeastern coasts of Europe is being harassed by torpedo planes as well as by bombers. The RAF has adopted this underwater weapon as an important part of their effort to control the sea areas near English shores.

Naval strategists have not always looked upon the aircraft torpedo as a practical weapon, influenced undoubtedly by the poor performance of both the early torpedo planes and the type of torpedo then available. Aircraft carriers had at that time not entered the picture and the planes must operate from shore bases. This necessitated incorporation of long-range characteristics and load carrying ability with resulting sluggish maneuverability in particular and poor performance in general. The torpedoes were controlled by such delicate mechanisms that tactics were limited to straight approaches at low altitudes. In spite of the feeling expressed by antiaircraft personnel that they could knock down these clumsy, low-flying attackers like tenpins, the torpedo plane advocates were firm in the belief that they were backing a good bet. They continued experiments in perfecting plane performance and introduced a more rugged and reliable torpedo. No longer does an antiaircraft gun crew view an approaching torpedo plane attack with calm or contempt. Today's planes are swift and maneuverable and the torpedoes they carry have a striking force to peril any ship.

In 1917 the R-6, a Curtiss-built biplane powered by an eight-cylinder "V" type water-cooled engine, known as the VR-CIO and built by the same manufacturer, appeared. The designation of this plane was changed in 1919 to R6-L when Liberty engines were substituted. The Douglas *Cruiser* of round-the-world fame, Martin's T3M and the Great Lakes TG all contributed to the advance in torpedo plane design.

Trials were carried out with twin-engined torpedo planes of the monoplane type in 1921. These planes were designed primarily for use as seaplanes. However, the development of the monoplane type gave way again in 1922 to the biplane at the introduction of the DT and the DT-2, manufactured by the Douglas company and powered with Liberty engines. These planes were capable of 115 m.p.h. speed, carrying a 1,700-pound Navy torpedo. The DT-2 was followed by the DT-4 and the DT-6. The Liberty engine during this time gave way to the Wright Model T-2 and the Packard 2500.

The Martin T3M-1 and the T3M-2, with Wright and Packard engines, were produced in large quantities during 1926 and 1927. These planes carried a great amount of additional equipment which had been found necessary during the preceding years of development.

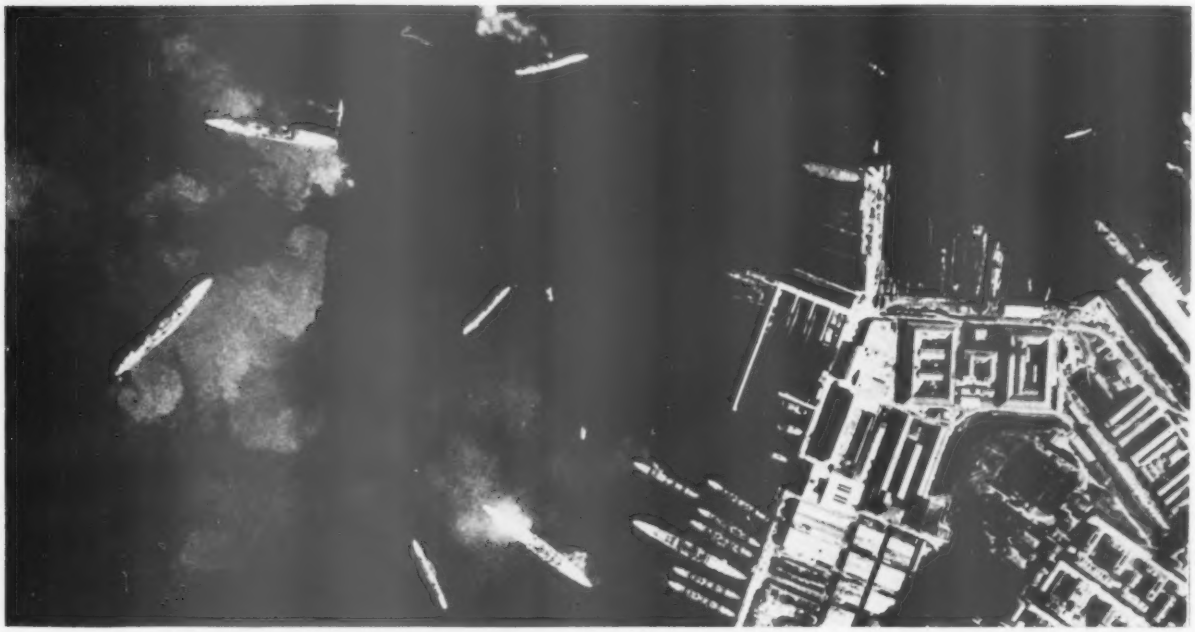
The T3M-2's were the first torpedo planes to go aboard an aircraft carrier for operations. This occurred in September, 1928, when VT Squadron One embarked on the *U.S.S. Lexington* at Hampton Roads, Va., and was carried to the west coast. The T3M-2's were the last of the water-cooled-engine torpedo planes in the U. S. Navy.

The T4M-1 was introduced in 1928 with a Pratt & Whitney *Hornet* 525 h.p. radial, air-cooled engine. This engine had a speed range of from 56 to 120 m.p.h., with a service ceiling of approximately 10,000 feet. Many parts of this engine were interchangeable with the *Wasp* engines so extensively used on other types of planes aboard the carriers. This feature made possible the reduction of spare parts and accessories carried.

The Great Lakes TG-1, introduced to the Naval service in April, 1930, was identical to the T4M in many respects. The difference in designation is due to the fact that orders for this type of plane were filled by two manufacturers; hence the T4M for Torpedo-Martin and the TG- for Torpedo-Great Lakes.

These planes were single-engined, tractor biplanes, with thick, heavy wings. The wings were not staggered and both had the same dimensions, thus giving no overhang.

In 1937, the Douglas company brought out the first modern torpedo monoplane and a torpedo specially designed for aircraft was issued to the service. The TBD-1, a three-place, low wing monoplane, was designed to give maximum effectiveness to two important weapons—the torpedo and the large armor piercing bomb. Its performance compared favorably with contemporary aircraft and its equipment insured the greatest accuracy in bombing and torpedo attacks. The bombsight and bomber were provided with ample space and vision. Release mechanisms, salvo signals, an automatic pilot, intercommunication between bomber and pilot and other vital needs



Graphic proof of the power of torpedo planes is this picture of sinking Italian warships at Taranto, Italy.

Douglas "Devastator" above, standard U. S. Navy torpedo bomber, is far advanced over British Fairey "Swordfish" that played such a deadly role at Taranto. Picture below shows effect on Italian warship after attack by RAF torpedo planes.

were carefully worked into a comparatively small space. Fixed and free guns and a powerful radio set completed the equipment necessary for carrying an attack to the enemy across hundreds of miles of sea.

The new torpedo increased tremendously the effectiveness of this form of attack because of its greater ruggedness and reliability. No longer was it necessary to give the antiaircraft gunners a "sitting shot." High speed in approach, low clouds and higher torpedo launching speeds could be used to make more deceptive and deadly attacks.

With the improvement of antiaircraft batteries, the necessary consideration has been given to the development of speed and high altitude capabilities in these planes in order that the essential element of surprise may be invoked. Some protection in the way of smoke screens and deck strafing is generally provided for daylight attacks by other airplanes working in co-operation to permit them to get within effective range.

Teamwork is the keynote of an efficient torpedo bombing squadron. A precision bombing run at high altitude or a deceptive torpedo attack from low clouds require excellent coordination of each aircraft crew and smooth formation work of the entire squadron. It is this close co-operation required between pilot, bomber and radioman-gunner, the understanding of the problems of one another and the satisfaction which comes from a good performance of the whole team that insures a good spirit in a torpedo plane squadron.

Each man knows there is a place for him in an aircraft crew if he will become proficient in bombing, radio or gunnery. One young seaman in my squadron earnestly requested bombing instruction. After weeks of careful training on the ground devices and dummy runs in the air he dropped his first practice bombs. The second bomb struck the rather small point-of-aim marker. Excitedly, he grabbed his microphone and without checking the switch which prevents broadcasting, shouting:

"I hit it. I hit it. I believe it now!"

During the initial stages of a campaign at sea the torpedo plane will make an excellent scout. Roaring off the carrier deck before dawn torpedo planes will search the area ahead and on the flanks at a speed of more than 200 m.p.h. Precise navigation will allow accurate position reports to be made when the enemy is first sighted. Squadrons remaining on deck already loaded with bombs or torpedoes can be put in the air within a few minutes and will be on their way before the enemy has sensed the threat. The choice between a bomb or torpedo load can be made after information concerning the target and

(*Continued on page* **224**)

VSB — The SCOUT BOMBER

Dive bombing, primary function of the scout bomber, is the U. S. Navy's famed and feared aerial weapon against both land and sea objectives.

These Vought-Sikorsky "Vindicators" are veteran Navy scout bombers.

VSB—THE SCOUT BOMBER

Ordered in large quantities by the Navy, Curtiss "Helldiver" (SB2C) is biggest of dive bombers, has 1,700 h.p. engine.

by Lieut. Comm.
J. N. MURPHY

Assigned to engineering section of the Bureau of Aeronautics, Lieutenant Commander Murphy benefits by aeronautical engineering postgraduate course completed at C.I.T. Graduate of Naval Academy in 1927, was designated Naval Aviator in 1929. Born in Washington, D. C., June 8, 1905. Now detailed to VSB design branch, he has seen extensive service in VF, VP and VO's.

THE scout-bomber, or VSB type, is the Navy's designation for the carrier-based scouting airplane and dive bomber. These two missions are combined in this type of airplane, the large bombs being replaced by auxiliary fuel tanks when it is desired to launch the airplanes as long-range scouts. The characteristics of this type are high speed, long range, the ability to carry bombs of large size, and strength to withstand the high accelerations encountered in the recovery from dives.

As a scout, this type can fly far from the carrier. It is desirable that the radio equipment which is installed in these airplanes be capable of transmitting and receiving messages over a considerably greater distance than the range of the airplane. This has been accomplished and our VSB's are equipped with radio equipment which not only assures good communications but also contains devices by which radio hearings may be taken. The radio direction finder is primarily for use in navigation but can be employed to "track" a vessel, should such vessel operate her radio.

Scouting over the sea requires precise navigation at all times. In order that the pilot may devote his attention to navigation and to reduce the physical strain upon him on long flights, all of the more modern airplanes are fitted with automatic pilots. Drift sights provide a means of determining the force and direction of the true wind at the altitude of the airplane. It is essential that the true wind be known and allowed for, since our pilots are expected to leave a ship and fly for many hours over the open sea and return to the carrier without the use of any radio aids whatever.

It should be remembered that scouting and observation were the missions first assigned to airplanes of the Navy. Originally these missions were carried out by shore-based seaplanes or flying boats. Very early in the history of Naval aviation, it was realized that aircraft must be carried with the Fleet wherever it might sail.

Many experiments and developments followed, leading to the Vought VE-7 and UO-1 seaplanes, which were carried on battleships and cruisers as early as 1920. Our first aircraft carrier, the *Langley,* carried the first carrier-based scouting airplanes. These were identical to those carried on the battleships except for the wheel-type landing gear. In 1928, the *Saratoga* and the *Lexington* introduced carrier operations on a modern scale, although the planes of the scouting squadrons based upon these ships were still the same type as were used on the battleships and cruisers, namely the Vought O2U series.

The fact that these airplanes were designed for use as catapult seaplanes or as carrier landplanes naturally penalized the performance of the carrier version. This feature was overcome when the first carrier scout, the Vought SU-1, was developed. Powered by an engine developing 600 h.p., this design was the forerunner of the present conception of the VSB type.

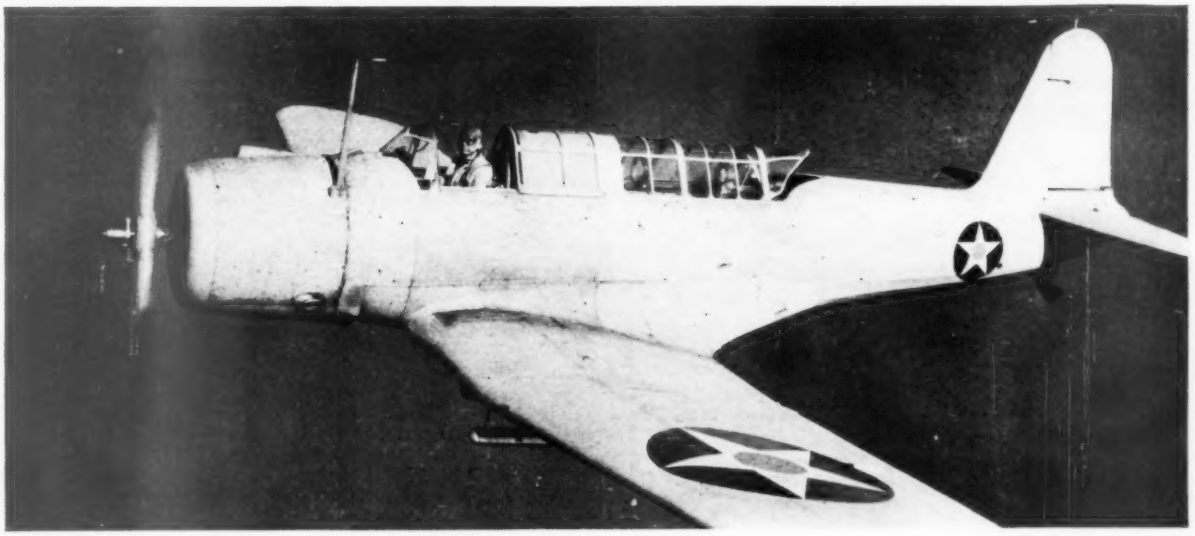
In 1935 the Vought SBU-1 was introduced in quantity. Its performance was very good for that period and, in addition, it was the first airplane to be equipped with landing flaps. As its designation (SBU-1) indicates, it was the first of our airplanes designed as a combined carrier scout and dive bomber. It was powered with the Pratt & Whitney *Twin Wasp, Jr.* engine of 700 h.p. and a Hamilton Standard controllable pitch propeller. The power plant cowling of this airplane introduced several new features which are now in general use. So outstanding were these cowling developments that a technical paper covering the subject, including the adjustable trailing edge flaps, prepared by R. B. Beisel of Vought-Sikorsky Aircraft, A. Lewis MacClain of Pratt & Whitney Aircraft and F. M. Thomas of the United Aircraft Corporation, had the unique distinction of winning both annual medals awarded by the Society of Automotive Engineers—the Wright Brothers Medal for the outstanding developments on aircraft design and the Manley Memorial Medal for development in power plant design.

Dive bombing is not new to the Navy. The technique of this type of attack has been developed and practiced by our Navy for years. Since this maneuver has been a continuing development definite records as to when or where the first dives were made for the purpose of releasing bombs are not available. It is known, however, that true steep dives such

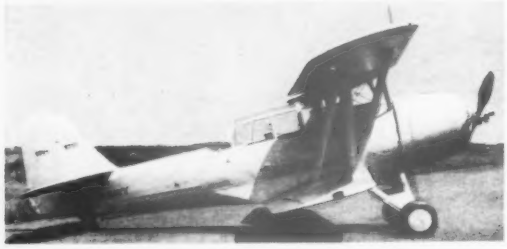
Powered with 950 h.p. Wright engine, Douglas "Dauntless" (SBD) is a current scout bomber type going to the Navy and Marines, also to the Army as the A-24. Forked device under plane's fuselage is bomb displacement gear.

Built at the Naval Aircraft Factory as the SBN, scout bomber above is based on a Brewster design that was known as the SBA.

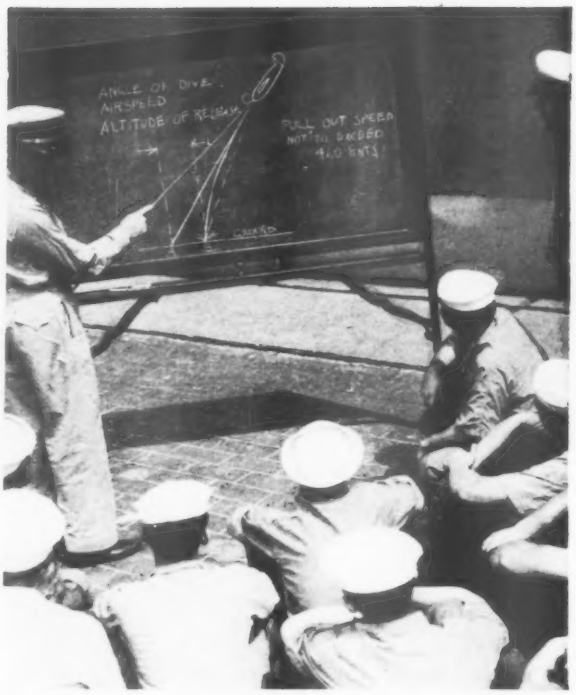
Vought-Sikorsky "Vindicator" (SB2U) below is a current dive bomber with the Navy. Export version of this went to French.



SCOUT BOMBER PROGRESS



Supremacy of U. S. Navy dive bombing is result of constant research, training and practice. In 1930 the Curtiss F8C-4 (top) appeared in quantity as two-place fighter and dive bomber. Then, second from top, came a Martin reputed to be first of its type built to withstand dive with half-ton bomb load. Similar in appearance and performance was the Great Lakes BG-1, shown beneath it. Directly above is the 1935 Vought-Sikorsky SBU-1, first plane designed as scout and dive bomber. It introduced landing flaps to Navy craft.



Blackboard instruction in dive bombing technique cautions against pull-out speed in excess of 460 knots (540 m.p.h.).

as are used in modern dive bombing were executed by the U. S. Marines in Haiti in 1919. Before that time, glide or shallow angle bombing had been practiced extensively during the World War. By 1927, the Navy had instituted regular dive bombing practices in which the various squadrons competed against each other. It is interesting to note that squadrons of the U. S. Navy, except the VPB (patrol bombers) and the VTB (torpedo bombers), practice dive bombing.

Thus, the fighter, the scout bomber and the battleship- or cruiser-based scout or observation pilots all are trained in the science of dive bombing. In the case of the latter, the airplanes with which they are equipped permit only short dives but, even so, the basic principles are mastered.

Dive bombers make every effort to approach their target quickly, but will take advantage of all cover in so doing. A favorite approach is one out of the sun or one in which clouds are used to screen attack until it has started. Once underway, a dive bombing attack is almost impossible to stop or break up. The attacking squadron may divide into divisions in order to disperse the enemy fighter patrols or the enemy anti-aircraft fire. With the modern aerodynamically clean airplane tremendous speeds have been recorded in dives, but such speed is not an advantage in regular operations because under such conditions it is impossible to pick up properly the point of aim. For this reason our VSB airplanes are equipped with speed-retarding devices.

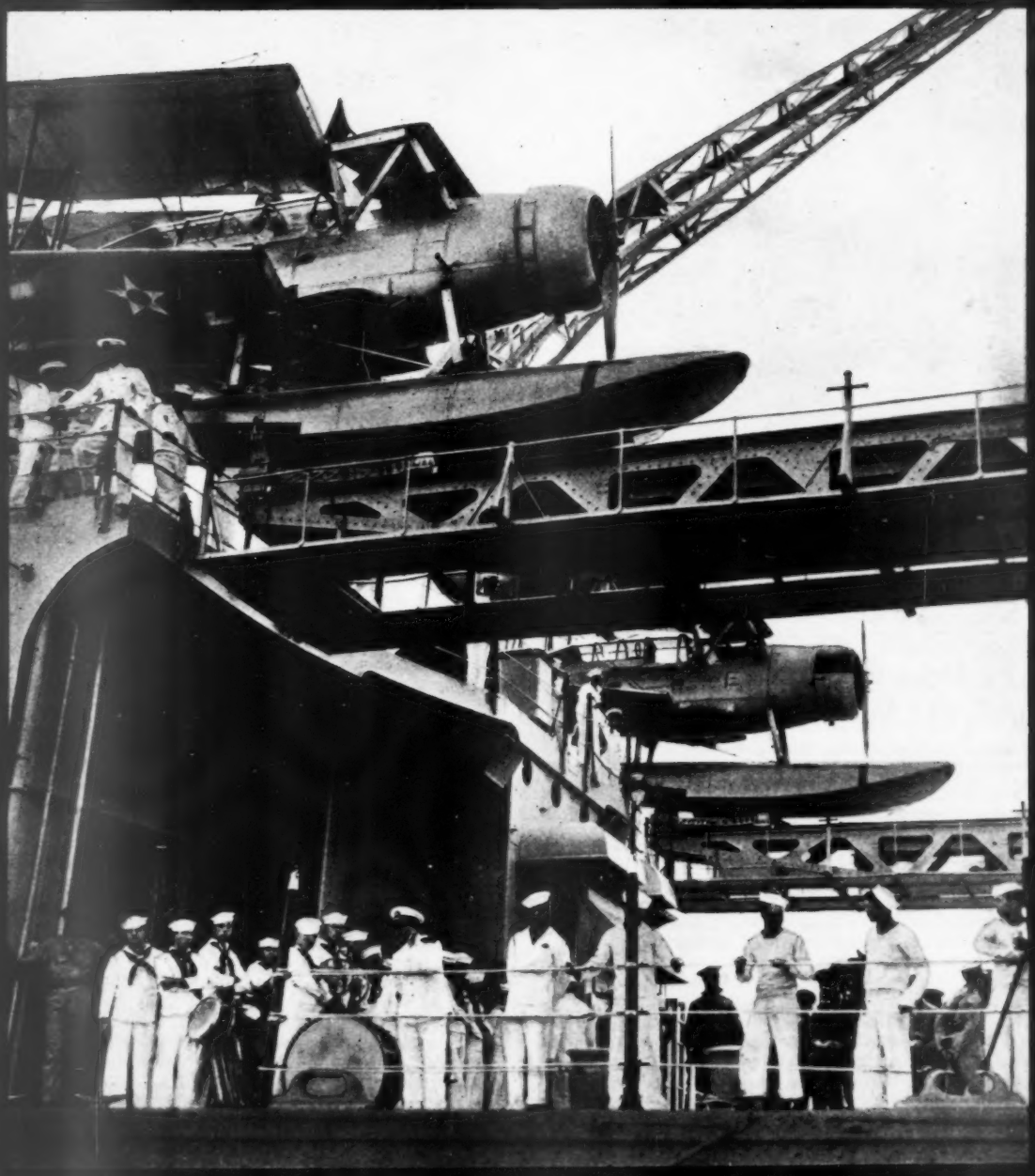
These devices hold the diving speed to a value which is fast enough to press home the attack quickly and at the same time permit comfortable aiming and recovery. The airplane is maintained in the dive to the lowest possible altitude, this altitude being determined by several factors. Obviously, the pilot must start the recovery in sufficient time to be in level flight before striking the ground or water. When diving in airplanes especially designed for diving, such as the VSB types, this distance is more often limited by what the pilot can stand rather than what the airplane will stand. The high centrifugal forces induced by the recovery or "pull-out" drive the blood from the pilot's brain, causing him to "go black," a sensation similar to fainting. The average pilot recovers very quickly from this condition but much can happen in a split second when approaching the water at high speed. The

(*Continued on page* 192)

VOS VSO

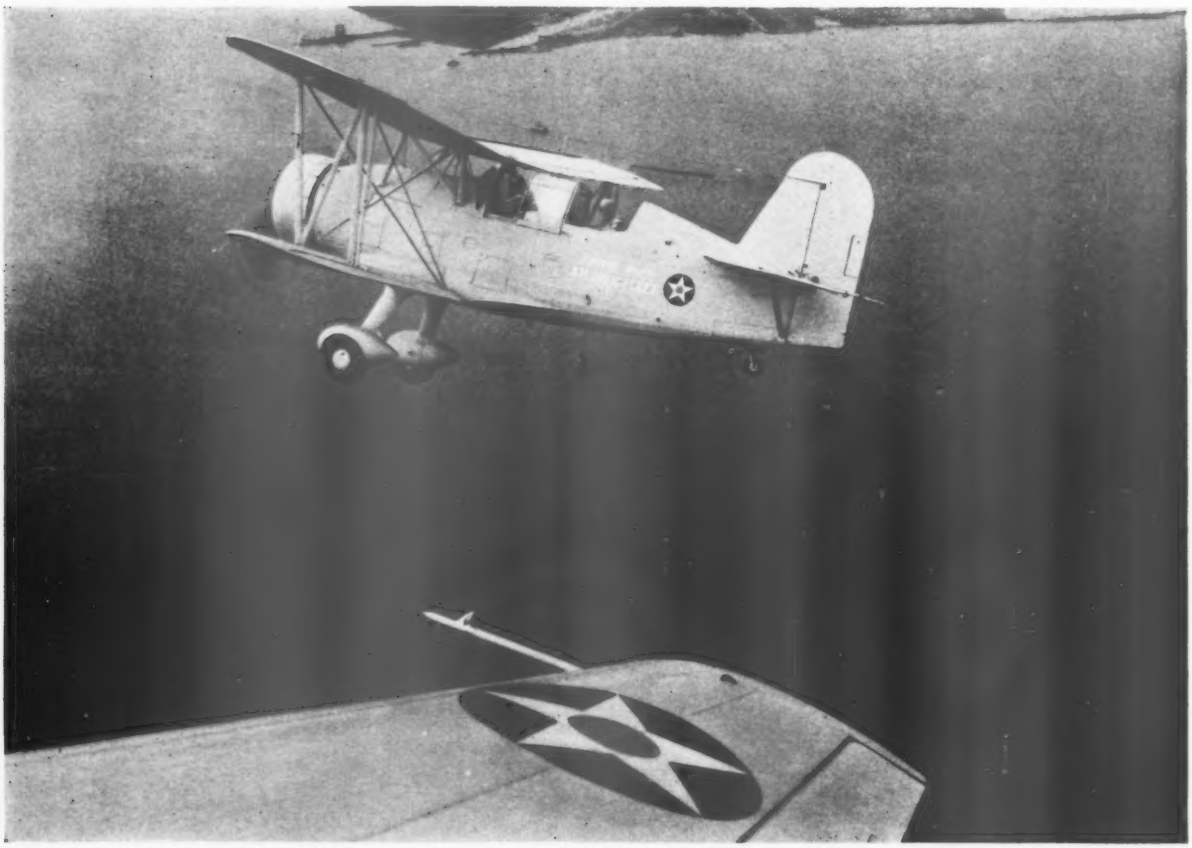
-OBSERVATION and SCOUTING

The U. S. Navy is equipped with eyes that can see farther, more accurately than any other navy in the world.



Curtiss SOC scouts on U.S.S. Houston catapults.

VOS VSO — OBSERVATION and SCOUTING



This SOC, like all Navy observation aircraft, is readily convertible to a seaplane for catapult use.

by Lieut. Comm. M. K. FLEMING, Jr.

Naval Academy graduate in June, 1926; designated Naval Aviator December, 1928, at Pensacola, Fla., Lieutenant Commander Fleming was active in mass flights before 1933 assignment to postgraduate work at the Academy. Was awarded master degree in aeronautical engineering by C.I.T. in 1936. Now, at 37, assigned to VOS-VSO design office, Bureau of Aeronautics.

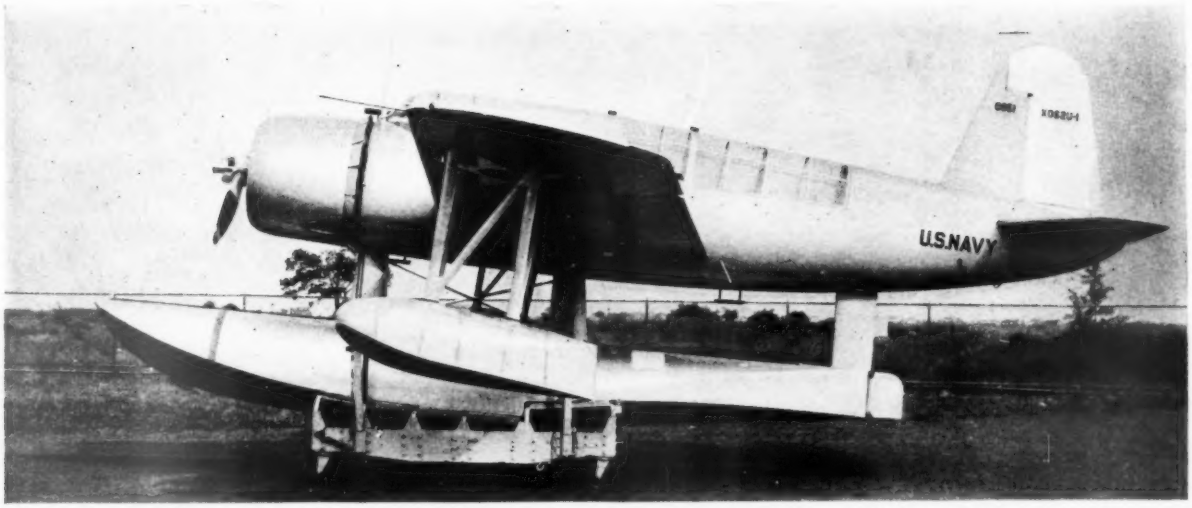
THE advent of observation and scouting seaplane usage on board battleships and cruisers may be traced to that day in February, 1911, when Glenn Curtiss landed alongside the former *U.S.S. Pennsylvania* in San Diego Bay. This was followed by the first successful catapult shot at the Washington Navy Yard by Lieutenant Ellyson. The successful completion of these two basic requirements of ship-based seaplanes demonstrated the possibility of extending aviation operations to the units of our Fleet.

The operations conducted from the *U.S.S. Mississippi* and the *U.S.S. Birmingham* by the aviation units in charge of Lieutenant Bellinger and Lieutenant Towers at Vera Cruz in 1914, first demonstrated the useability of this type of aircraft in the face of enemy fire. This demonstration was followed in 1919 by the decision to equip every battleship with seaplanes and catapults.

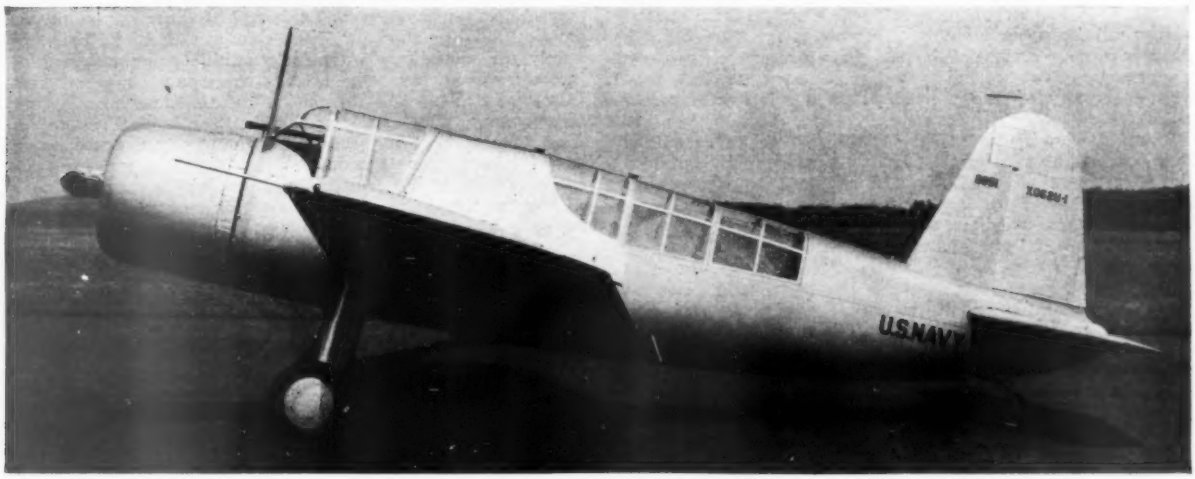
The initial employment of these seaplanes was followed by such rapid development and application that today there is a far-flung organization of scouting and observation squadrons operating from virtually every combatant ship of the Navy.

These hundreds of airplanes are organized into basic units of one or more airplanes based on board each ship and attached to the gunnery division. This unit is self-contained and is in charge of the senior pilot who is known as the Senior Aviator. The aviators are organized to perform all the duties of a regular squadron, such as navigator, engineer, radio, gunnery, material, personnel, etc. These duties are supplemented by strictly shipboard duties such as Officer-of-the-Deck, and assignments to Naval Courts and Boards.

The squadron organization is based upon the tactical organization of the parent vessels, all aircraft units of the same division of ships being assigned to the same squadron. For example three battleships may be organized into the Fifth Battleship Division. The three aircraft units would then be organized into Observation Squadron Five. Each aircraft squadron is assigned a squadron commander, who is attached to the battleship acting as the flagship of the battleship division. Quite frequently the ranking senior aviator is also designated as the squadron commander of the aircraft units.



Illustrative of the versatility necessary in a scout-observation design are these two views of the Vought-Sikorsky "Kingfisher" (OS2U). Its float equipment must be light, yet sturdy enough to withstand rough seas and catapult launching from battleship or cruiser. Wheel-equipment must withstand airport and carrier use.



The aircraft squadrons of the same type are organized into a wing. The wing commander may also be the senior squadron commander and is usually assigned to the staff of the commander of all the parent vessels. In this illustration it would be Commander Battleships.

The organization of the scouting seaplanes based on board the cruisers follows the same principles. The essential difference between the observation and scouting seaplanes is their difference in basic employment. The observation type essentially extends the field and accuracy of the main battery spotter, whereas the scouting type extends the vision of the force or unit commanders to points hundreds of miles away. The former improves the accuracy of gunfire and the latter permits extreme enlargement of the area scouted by one vessel equipped with aircraft.

This increase in area can be easily shown by comparison of the area scouted by a single ship with and without aircraft. A single ship scouting ahead can cover an area 10 nautical miles wide and 250 nautical miles long in 10 hours at a speed of 25 knots, assuming visibility at five miles. This same ship proceeding at 25 knots with four airplanes flying at 120 knots and spaced 10 nautical miles apart can, in 10 hours, cover an area roughly 50 nautical miles wide and 780 nautical miles long. This is an increase in the area scouted from 2,500 square miles to 39,000 miles. Thus is explained the term so frequently heard: "Naval aviation is designed to increase the efficiency of the Fleet."

It is to be noted that in the general classification of aircraft by means of letters, the secondary mission of one class is the primary mission of the other class. In the class VOS airplane the "V" is for heavier-than-air, the "O" is for observation and the "S" is for scouting. Since the first letter after "V" is used by our Navy to denote the primary class of airplane it follows in this example, that scouting is the secondary mission. Similarly the VSO has scouting as the primary mission and observation as the secondary mission.

The mission of these early types of the VOS and VSO classes was combined and was to extend the field of vision, destroy enemy aircraft and carry out minor offensive operations. The modern application of ship-based aircraft requirements has lead to the refinement of the early mission, extension of the area of operations and the effective spotting of the main battery gunfire of the surface ships. The extension of the offensive operations has made it necessary to include aerial depth charge attacks upon submarines, modified dive bombing on light surface vessels and smoke screen laying.

The ability of the Naval observation seaplane to carry out these present day missions has been incorporated in the airplanes now operating from the battleships of our Fleet. Present day airplanes of this type are capable of being launched and retrieved from their parent vessels without materially affecting the course and speed of the latter. In the air, the accurate spotting of the gunfire of the battleships has materially increased the effectiveness of the latter at long ranges and

One of the latest scout-observation types now in production is the two-place Curtiss "Seagull" (SO3C). Its in-line air-cooled Ranger engine marks the first use of this type power plant in tactical Navy planes.

is indispensable during indirect fire when the target is not visible to the surface ship.

This fundamental mission is further augmented by the ability of the observation seaplane to carry several depth charges for long periods of time and to accurately release these weapons upon submerged or surfaced submarines, thus providing security to the battleships from enemy submarine attack.

The added use by these airplanes of light bombs for modified dive bombing attacks upon light surface vessels should reduce the effectiveness of the latter during torpedo attacks against our battle line. Furthermore, the spotting mission requires long endurance, which in turn permits long range scouting to be performed by this type when carrier based scouting airplanes are not available.

The ship based scouting seaplanes require the same characteristics as the observation seaplanes with, however, high speed and maximum range being considered paramount.

These performance requirements must also be supported by adequate gunnery, radio and navigation installations. The offensive and defensive characteristics, in order to be effective, must be completed by the addition of protection for the fuel, oil and personnel against enemy gunfire.

The attainment of these features in an airplane would not be difficult, were it not necessary to so restrict its weight and size that the design is initially heavily penalized. Moreover, these restrictions are augmented by the necessity for exceptional ruggedness and strength to withstand routine landings in mountainous seas. One would think that certainly the restrictions would stop at this point, but such is not the case, because the landing speed must be very slow. Also, the airplane must be able to taxi at high speeds in very rough water without damage, without an undue amount of spray and without destroying the structure by the accelerated corrosion conditions encountered.

The design of the cruiser based seaplane is subjected to a further restriction by the necessity for incorporating folding wings and a short span, non-folding horizontal tail surface.

The insistence of the Bureau of Aeronautics upon the airplane engineer's strict compliance with the physical limitations imposed by the available space and weight limitations of the battleships and cruisers has resulted in airplanes which have not only proved their need as a component arm of the surface ships but at the same time have not restricted the internal and tactical handling of the latter. This avoidance of interferences during the shipboard handling of the airplanes has also materially increased the effectiveness of the airplanes by permitting development of the very short space of time now required for launching and retrieving operations.

The daily operation of the observation and scouting sea-

The Navy took over the Curtiss SOC design recently, subsequently produced a number of almost identical planes bearing designation SON. These planes were built at the Naval Aircraft Factory, Philadelphia.

planes during severe conditions of sea and wind without serious casualties, with a low ratio of minor damage per airplane per landing and increasing freedom from corrosion problems amply demonstrate the effective manner in which the related requirements have been fulfilled.

The succession of airplanes developed and operated from battleships and cruisers during the past 15 years has constantly been accompanied by increased performance. Furthermore, the ratio of maximum speed to stalling speed has been constantly increased in spite of the severity of the design requirements and the heavy air drag and weight penalty imposed by float type landing gear.

The forerunner of the modern observation and scouting seaplanes was known as the UO-1 observation seaplane. This was a stick and wire biplane equipped with a flat-bottomed wooden main float. Its maximum speed of 120 m.p.h., landing speed of 60 m.p.h., moderate endurance and ruggedness compared favorably with the fighters of that era. The rough water landing characteristics of this airplane were not unlike those of a bucking bronco. Many a pilot, after a cruise in this model, felt well qualified to successfully compete in a rodeo. In fact, the earthbound crews of the battleships derived great amusement from watching the returning airplanes bounce "as high as they flew" during rough water landings.

This era of wooden airplanes was, in the latter part of 1928, replaced by metal models. The airplane of this period was the Vought O2U series of observation seaplanes of the trussed steel fuselage and aluminum alloy floats. These airplanes were also operated from the cruisers of the Scouting Force as well as from the battleships. A maximum speed of 134 m.p.h., a stalling speed of 58 m.p.h., endurance of 5 hrs. 30 mins., improved stalling characteristics, increased ruggedness and increased radio range were definite improvements over the previous type. Occasionally, however, a pilot could reach back after a hard landing and gather up the loose fabric resulting from fuselage distortion. This was considerably lessened by the advent of the deep "V" type of main float.

The arrival of the Curtiss SOC type of airplane introduced exceptional landing qualities to this class of airplane. Furthermore, the improvement in maximum speed, range and endurance did not prevent a reduction in the stalling speed. These characteristics were also accompanied by the necessary increase in range of the radio sets. Such improvements were not easy and were only accomplished by the application of automatic leading edge slots and manually operated trailing edge flaps. Although these airplanes have been in service for some time, they are in the process of being equipped with the latest improvements dictated by the present European war.

The recent Vought-Sikorsky OS2U seaplanes which have been sent to the Fleet units have been equipped with the very latest protection and radio features without materially reducing their performance margins over the SOC type. These replacement airplanes were designed solely for observation seaplane requirements and are to be paralleled in the scouting seaplanes by the new Curtiss SO3C-1.

The performance of this latest scouting seaplane is outstanding when the severe design restrictions are considered. The fact that the ratio of maximum speed to stalling speed is above four, indicates the constant progress which is being made in this class of airplane.

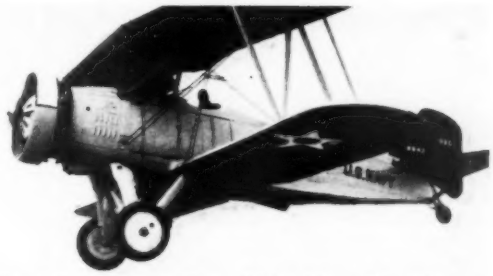
The accomplishments in the production of capable and efficient airplanes have not lessened the problems of a modern observation and scouting seaplane pilot. For the present day pilot must in reality be a specialized "jack-of-all-trades"—expert in each and every duty that may be required.

He must, above all, be a good pilot capable of handling his airplane in all sorts of weather and seas, the latter requiring a practical knowledge of seamanship for making daily landings in extremely rough seas. Cross-sea and cross-wind landings require good airmanship followed by the ability to make spot approaches on a fast moving object in heavy swells. An error can be costly in time as well as in material and may well result in injury.

This type of pilot, must, if he is to be an asset to his Fleet, be a good Naval officer as well as a pilot. A knowledge of the general principles and problems of shipboard gunnery is essential for outstanding results in spotting gunfire. Scouting requires a working knowledge of the methods used, accurate

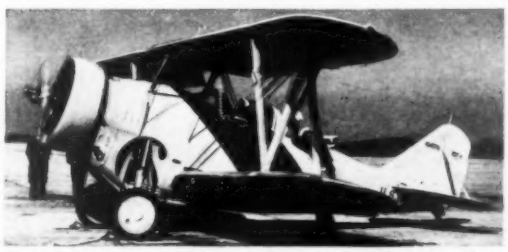
(*Continued on page 252*)

A fundamental of observation aviation is the catapult. The plane above is the first to be so launched. Compare it with recent "Corsair" below. Compressed air operates catapults.



Observation types sometimes did bombing missions in past. Curtiss O2C-1 above, "Helldiver" ancestor, was used then.

A standard observation type until recently was the Berliner-Joyce OJ above. Now obsolete, they are torn down at schools.



Grumman produced this two-place scout, the SF-1, which later became the basis for the FF-1, a well-liked two-seat fighter.

VJ—The Utility Plane

Workhorses of Naval aviation are the cargo and transport planes and their unsung, hard-working pilots.

A typical utility squadron is VJ-3, equipped with everything from a bicycle to a twin-engined Grumman JRF-4.

★

by Comm.
C. T. DURGIN

Tours of duty as aide on the staff of commander in chief, U. S. Fleet, and in the office of Chief of Naval Operations provided Commander Durgin a valuable background of executive experience. Now 48, is in charge of flight division, Bureau of Aeronautics. Born in Palmyra, N. J., he was appointed to the Naval Academy in 1912, and designated a Naval Aviator in 1920.

"JOIN the UtWing and never see home," said a former commanding officer of the Utility Wing.

"Yes," said one of his pilots who had just finished a job entailing a rather fine bit of flying and seamanship in landing his plane off an outlying island and beaching it through the surf in order to bring back an emergency case, "there's always something new coming up. If I'm not flying over a desert looking for a lost prospector or making night target runs for a battleship, they ask me to fly over to Santa Rosa Island to pick up some gink who was so inconsiderate as to break out with a burst appendix on a Sunday afternoon."

This pilot succinctly described the role of the Utility Wing—there is always something new coming up with never a dull moment in the daily chore of a utility pilot.

While the utility planes do not have the spectacular appeal of the fighter, dive bomber, scout or patrol plane, they are certainly compensated by the variety of duties offering access to training of the widest possible scope.

Essentially, the utility plane is an adaptation of a commercial plane for Naval utility use; or, as someone has called them, they are "the workhorses of the flying fleet." Their mission is to provide aerial services of all kinds to the Fleet. In order to carry out this work efficiently there is assigned to each aircraft carrier, aircraft tender and to each Naval air station, a utility unit of two to four planes. In addition to these many small units there is the Utility Wing, composed of five large squadrons employed constantly with the U.S. Fleet.

As one Utility Wing officer said, "Any attempt at a resumé of the Utility Wing's history reads like the case history of a rejected alien or a bad penny who, despite contempt and studied shunning, keeps coming back and constantly popping up until, in desperation, someone has to do something about it."

That something was the organization of the Utility Wing. Utility planes were necessary, but considered slightly underfoot by the skeptical Naval aviators who wondered what, if any, were their duties.

After the organization of the Utility Wing a few years ago it was beleaguered with the name "home guard" because it was so deeply entrenched at its home base that it was believed nothing could blast it out.

However, a change was inevitable as the size of the seagoing Navy increased with more and more stress placed on antiaircraft defense, and greater mobility of the forces afloat. Today, squadrons of the Utility Wing are found wherever large units of the Fleet are operating.

The mission of "providing aerial services" may sound like a prosaic task. To those who wonder exactly what the Utility Wing does, a brief account of some of the assignments will indicate their value and why they are considered a necessary adjunct to each Naval air station and to the forces afloat.

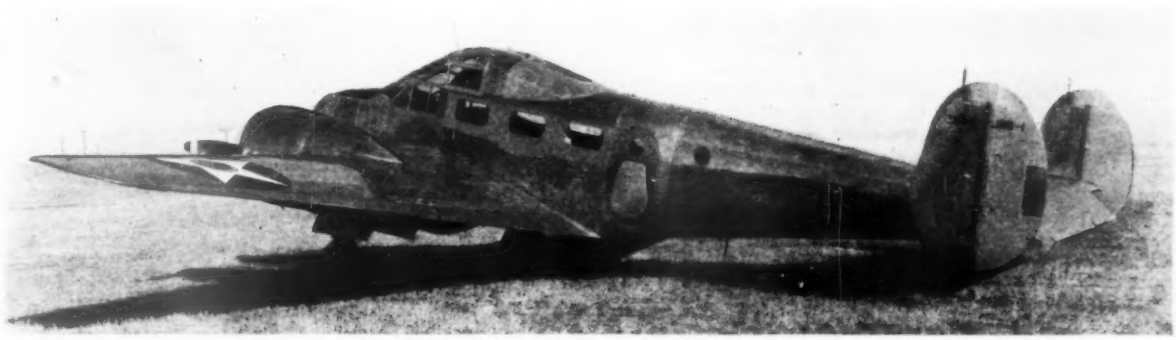
Roughly, the field of activity covers the following points:

The utility squadron is used for towing target sleeves for all types of target practices for battleships, cruisers, destroyers and submarines; for torpedo recovery work, for submarine and destroyer practices and the photographing of this work for later analysis. Photographic assignments will vary from aerial views of ships, air stations, points of possible historical or recruiting interest to shooting scenes in such motion pictures as "Wings of the Navy" and "Flight Command." Other coverage will include bombing and antiaircraft practices. Aerial mapping is an assignment that assumes major importance. Utility Wing mappers have recorded geography from the Aleutian Islands to the Caribbean.

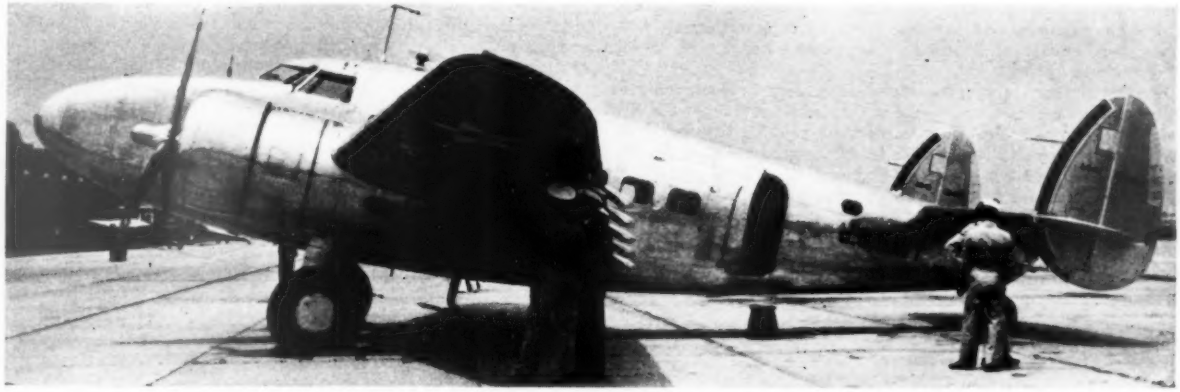
Scheduled mail and passenger service is maintained. Administrative flights for flag officers and other Government officials are constantly being carried out. On the west coast,

In the 1920's several Loening OL-9 amphibians of VJ-1 did pioneer aerial mapping and photography throughout Alaska.

Along with everyone else in aviation, the Navy found some use for the tri-motored Ford (RR-4). This was based at Anacostia.

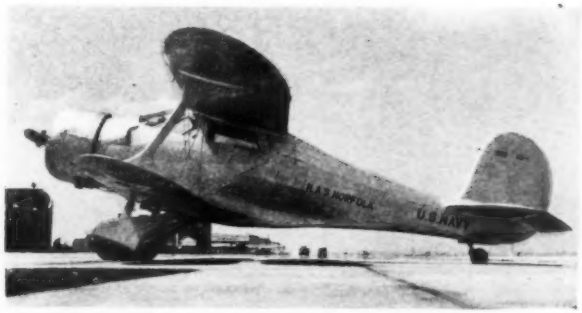


Developed primarily for photographic work with utility squadrons, this Beechcraft JRB-1 can be used for cargo and personnel transportation. A similar adaptation of this Beechcraft is used as photographic ship by Army.



Essentially used for high-speed transportation of official Navy personnel, airliners like this Lockheed R40-1 usually are almost identical to commercial versions. R40-1 is related to the Lockheed "Hudson."

Strikingly similar in design to the OL-9 at the top of the page, the Grumman J2F-1 is a well-liked type in use today.



Listed as a utility type, this Beechcraft GB-1 is kept at the Naval Air Station, Norfolk, Va., for administrative use.

Sikorsky JRS-1 amphibian, used as UtWing transport, carries 15 passengers. Powered with two 750 h.p., top speed is 190.

Grumman JRF-4 is fitted with special hatches for taking vertical photographs. It also is used in target towing work.

precipitous San Clemente Island, 90 miles at sea, is the scene of weekend landings of several Grumman amphibians from the Utility group to work with the Fleet gunnery school.

Towing target sleeves for the training of antiaircraft batteries is undoubtedly the utility plane's major task. The growing demands of the Fleet for increased new practices and night antiaircraft practice presents a challenge to the Utility Wing. This work requires a high degree of skill on the part of the pilots and crews of the towing planes to insure that the targets are at the firing point on schedule and that the many simulated forms of attack are thoroughly understood and properly executed. This means accurate navigation on long flights over the sea, careful piloting and good judgment in guiding the target sleeve. The long canvas or muslin target, similar to a wind sock, is attached to a lengthy towing wire so that it will follow the path that simulates a real bombing, torpedo or strafing attack. A great deal of study is necessary in order to be thoroughly familiar with the many diverse forms of attack that might be used by enemy aircraft.

While the pilot is absorbed with these details, his crew, back in the bowels of the plane, are busy operating the complicated towing equipment and keeping in radio communication with their base station and with ship or shore battery with which the plane is working.

At completion of target practice the wire is detached and the released target floats to earth. In some practices, the firing batteries will dip their bullets in various colored dyes. When the target is rescued and examined the colors left by the bullets provide a check on accuracy.

The demands for night target practice, with all lights blacked out, is an added test for the firing ships or shore batteries, to say nothing of the utility plane personnel.

Photographing target practices includes fire from surface ships and all forms of aerial bombing. This means a still photograph of every salvo or bomb drop, and, in case of rapid fire, a moving picture record so that the results can be carefully analyzed.

Torpedo recovery work can be both exciting and monotonous. A utility squadron assigned to this duty will hover above and back of the firing ship. As the torpedo is released, the plane follows to the point of target, which may at times be a mile or two miles from the ship.

Practice torpedoes have a buoyant head, and float after they have run their course. When the plane is directly over the floating torpedo, it makes a shallow dip indicating its location. A surface ship then puts out with towing rigging. Care is taken to insure that there is no latent power left in the torpedo motor before the towing apparatus is adjusted. Back at the ship the torpedo is hoisted aboard and made ready to use again.

Occasionally 65 or 70 torpedoes are fired simultaneously by destroyers and airplanes at a battle line. Moments like this tax the skill of the best recovery pilot. A loss of a torpedo is not small change when you consider they cost approximately $10,000 apiece. Often a utility plane pilot must spend hours crossing and re-crossing an ocean area searching for one of these strays.

In addition to these major functions (and playing postman to the Fleet by providing a daily mail service between various units of the Fleet) the Utility Wing conducts experiments, instrument tests and provides a ready ambulance plane to answer emergency calls to outlying islands, isolated places along the coast or to ships at sea. Available at all times is a seaplane to be dispatched to the scene of any crash that may occur at sea.

For example, Utility Squadron Two recently made two emergency trips to San Nicolas Island. The first request was to transport a 74 year old man, suffering from a paralytic stroke, to a San Diego hospital. Four days later, the second emergency call came from San Nicolas Island requesting transportation and medical aid for an eight year old girl who had been thrown from a horse, fracturing a leg. These two trips assisted the oldest and youngest inhabitants of the island.

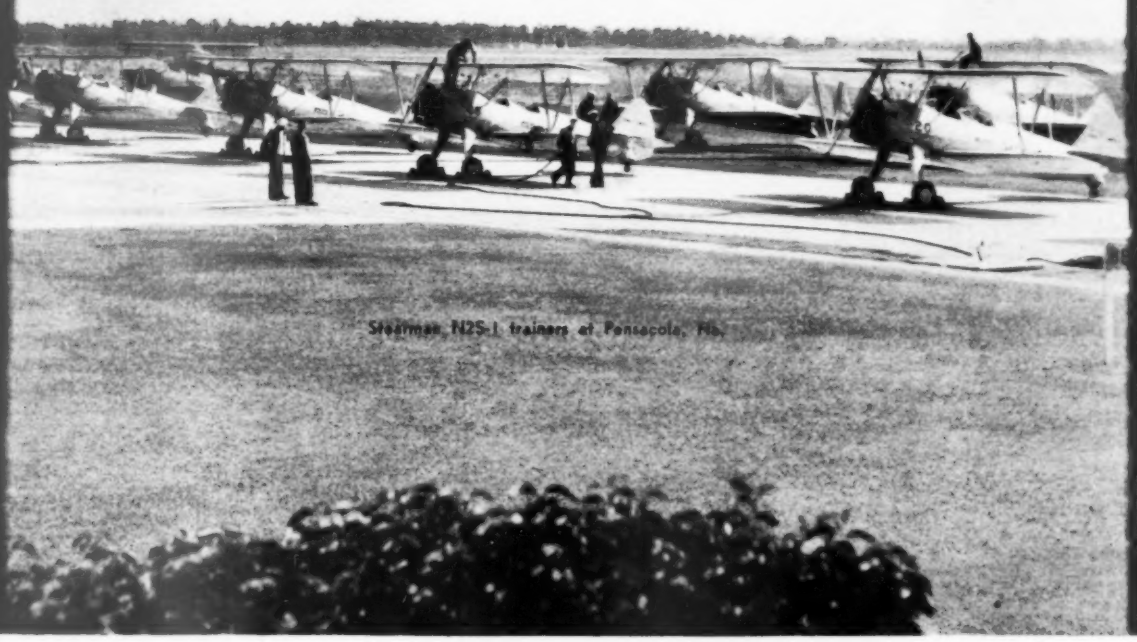
(*Continued on page* 246)

Navy's coffee mess tradition is scrupulously observed by UtWing personnel. Radiomen enjoy cup after towing flight.

Ordnance men roll targets for towing. Dark target is for antiaircraft guns. White sleeves are for aircraft gunnery.

TRAINING
The Naval Aviator

Nowhere on earth can a young airman get better training than that offered by the U. S. armed forces. Hence Our Naval flyers rank among world's finest.



Stearman N2S-1 trainers at Pensacola, Fla.

TRAINING THE NAVAL AVIATOR

by Capt.
A. C. READ

Since graduating from the Naval Academy in 1907, Captain Read has held many important posts, now is commandant, Naval Air Station, Pensacola, Fla. Born in Lyme, N. H., March 29, 1887, he commanded NC-4 on 1919 transatlantic flight, was assistant chief, Bureau of Aeronautics, 1936-38; served as commander of the U.S.S. Saratoga prior to his current assignment.

TWENTY-SEVEN years of experience lie behind the training of our Naval aviators. It was in December, 1914, that the Pensacola Naval Air Station, the Navy's first, rose like the proverbial Phoenix out of the ashes of an abandoned Navy Yard. Under the command of the late Capt. H. C. Mustin the newly-founded school staffed with three instructors and about a dozen mechanics, blazed the skyways and laid the foundation for Pensacola's sobriquet: "The Annapolis of the Air."

Through the years Pensacola expanded and kept apace with the Fleet's demands for Naval aviators and Naval aviation pilots, but with the advent of the national emergency it became apparent that the Florida incubator alone could not hatch enough birdmen to meet the aeronautical requirements of the proposed two-ocean Navy. Setting for itself a goal of 17,000 trained aviators, the Navy Department solved its dilemma by rushing to completion two new Naval air stations, each patterned after Pensacola.

Today at nearby Jacksonville, 200 aviation cadets, two-thirds of Pensacola's present intake, are arriving monthly. To the southwest across the Gulf of Mexico, Corpus Christi, with its vast training center, is on a training par with the Pensacola speed up program. Staffed by Pensacola-trained instructors and blessed with the Pensacola flight formula, "Jax" and "Corpus" are already graduating aviators, trained, as a recent advertisement put it, ". . . to outfly the eagle they are pledged to defend."

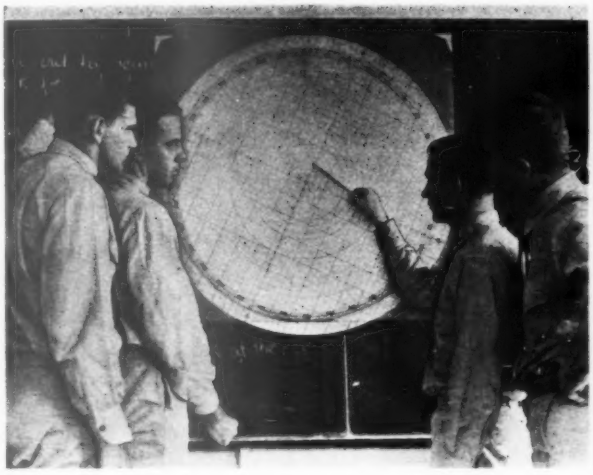
Those who undergo training at one of the Navy's flight centers fall into one of four general classifications, viz., regular and reserve officers of the Navy, Marine Corps and Coast Guard; selected enlisted men of the same three organizations; aviation cadets; and civilian pilots who as members of the reserve report for the Navy's "refresher" course.

Several hundred enlisted men are undergoing flight training at the present time. Those selected for the course must: (1) Be recommended by their commanding officers; (2) Be not over 27 years of age on July 1 of the fiscal year during which application is submitted; (3) Be physically qualified and temperamentally fitted for duty in actual control of aircraft; (4) Be a chief petty officer or petty officer of the Seaman, Artificer or Aviation Branches; (5) Be capable and willing to qualify for an aviation or radioman rating prior to completion of training; (6) Must have at least five years of obligated service on date class convenes, and (7) Must never have been previously assigned to aviation training, and for any reason dropped therefrom. While a high school education is not required the successful completion of a high school course carries weight in the selection of those who are to undergo training. While in a flight status, enlisted men receive flight pay which represents a 50 per cent addition to their base pay.

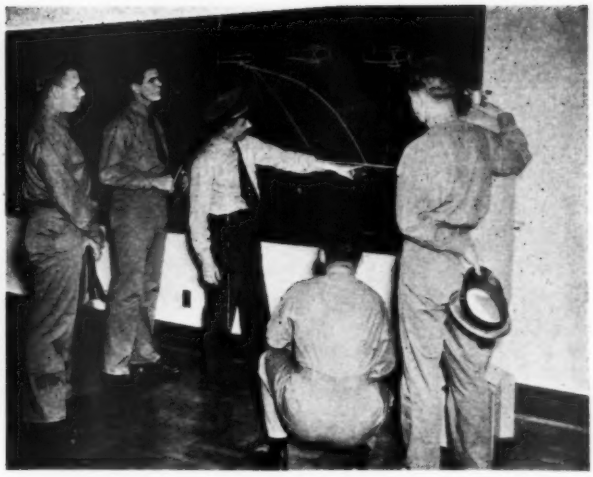
The cadets comprise approximately 85 per cent of the enrollment. For obvious reasons, their training will be the subject of this article.

To become a cadet, the candidate must: (1) Be between the ages of 20 and 27; (2) Be native-born, or hold citizenship by virtue of the naturalization of his parents, which naturalization must be of at least 10-years standing; (3) Be unmarried and agree to remain so for at least two years; (4) Have at least two years of college, or one year of college plus three years of good business experience; (5) Be able to pass rigid physical and psychological examinations and, (6) Agree to remain on active duty for a period of four years unless sooner released by the Navy Department.

Seventeen thousand Navy pilots are being trained in present program. These primary trainers at Pensacola are Stearman NS-1's.



Especially vital to the Navy airman is his knowledge of navigation. Aviation cadets constantly plot and fly intricate courses.



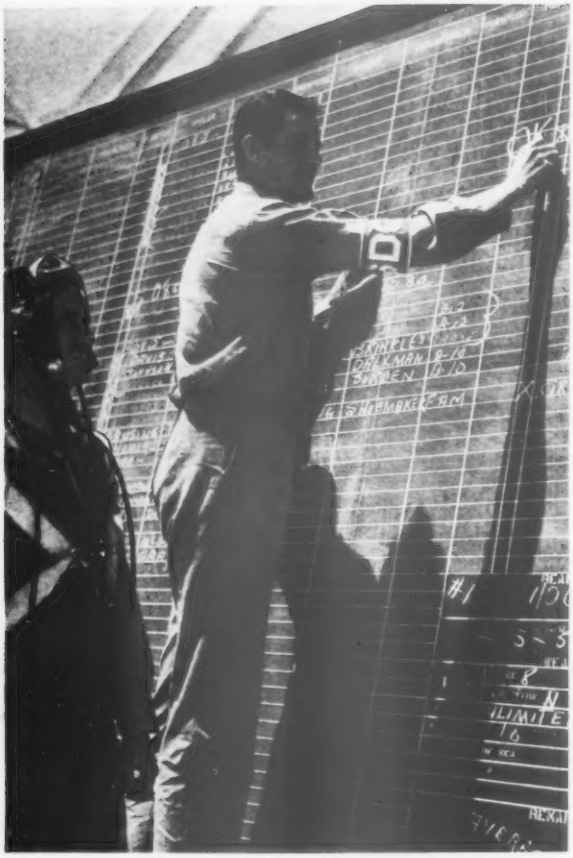
Cadets learn bombardment, both by theory and practice, at flying school. Instructor above is describing trajectory of bombs.

Flying cadets don't always fly. These Pensacola students are attending a regular class in engine and carburetor operation.

Physical training for Naval aviation men keeps them trim and fit for exacting duties. Above is a regular morning exercise.

This cadet studies schedule on blackboard of Jacksonville, Fla., training base, before going out to simulate carrier landings.

Students and instructors dine together in expansive mess hall at Pensacola. Table at far right is reserved for school staff.



Giant blackboard at training base shows whereabouts of planes and pilots, gives weather data. Duty Officer keeps the records.

Neatness and efficiency is a fundamental Navy principle. Wardrobe of Naval aviation cadet always must be kept in this manner.

Prospective cadets apply for flight training at their nearest Navy recruiting offices or nearest Naval Aviation Cadet Selection Board, one of which sits at each of the 16 geographically located Naval Reserve Aviation Bases. These bases are maintained at: Boston (Squantum), Mass.; New York (Floyd Bennett Field, Brooklyn), N. Y.; Navy Yard, Philadelphia, Pa.; Washington (Anacostia), D. C.; Atlanta, Ga.; New Orleans, La.; Dallas (Grand Prairie), Tex.; Detroit (Grosse Ile), Mich.; Chicago (Glenview), Ill.; Minneapolis (Wold-Chamberlain Airport), Minn.; St. Louis (Robertson), Mo.; Kansas City (Fairfax Airport), Kan.; Long Beach, Cal.; Oakland, Cal.; Seattle, Wash.; and Miami, Fla.

Those prospective cadets who qualify for training, enlist as seamen, second class (class V-5, aviation), in the Naval Reserve and report to one of the above-mentioned sixteen Naval Reserve Aviation Bases for elimination training. While there, they receive pay at the rate of $36 per month and subsistence at the rate of $1 per day. Their uniforms are furnished free as is their transportation from their homes to the elimination bases.

Flying part time, the future cadets receive approximately 10 hours of dual instruction and one hour of solo work. The balance of their 30-day course is devoted to radio, the care and handling of planes, infantry drills, and lectures on such subjects as Naval discipline and the rules of the air.

Throughout the 30-day period they are carefully observed to see whether they possess the aptitude to warrant the spending of the thousands of dollars necessary to transform them into first-class pilots. Only those whose ground school and aptitude marks meet the required standards are given appointments as aviation cadets. Those who fail to qualify for flight training may be given opportunity for ground assignments or are honorably discharged from the Naval service and are returned to their homes at Government expense.

While undergoing training, aviation cadets receive $75 monthly, plus a subsistence allowance of $1 per day. In addition, they receive a number of items free—uniforms, quarters, medical and dental attention, and premiums paid on a $10,000 Government life insurance policy. Their status as cadets is analogous to that of midshipmen at Annapolis.

As ensigns in the Navy, or as second lieutenants in the Marine Corps, graduate cadets receive base pay, flight pay, subsistence and rental allowances totaling $245 monthly.

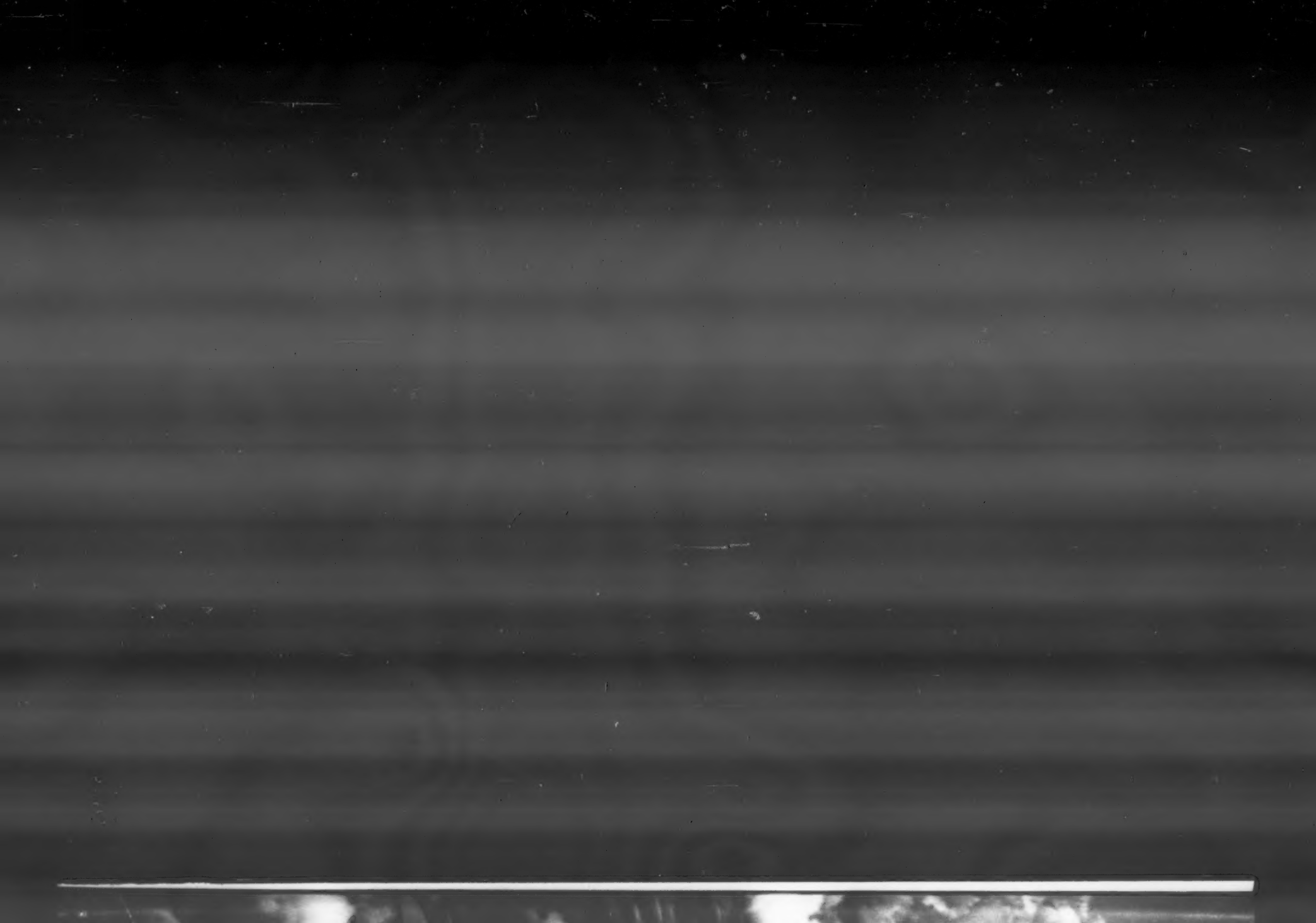
Even more attractive than the good pay and the glamour of Navy life, is the opportunity that each cadet receives to qualify for a permanent commission in the line of the regular Navy on the same basis as graduates of the Naval Academy. Recently, over 300 Pensacola graduates so qualified for permanent commissions.

Those who do not qualify for permanent commissions or who do not elect to accept them, receive extra compensation in the way of a cash bonus at the rate of $500 annually for each complete year of active service other than duty as aviation cadets undergoing training, provided their duty has been continuous for one or more years. The bonus, paid in a lump sum upon release to inactive duty, is prorated for fractional parts of a year in the event the release is not at the individual's request or as the result of disciplinary action.

Upon arrival for aviation training, cadets spend six weeks on ground instruction before he takes to the air. The first two weeks of their training is a concentrated indoctrinational course, which is designed to give them a general picture of the Naval establishment and to educate them as to what is expected of cadets. During this period it is impressed upon them that they must learn to be Naval officers, as well as Naval aviators.

Older and more worldly-wise than West Point and Annap-

(*Continued on page* 84; *additional photos on page* 83)



SNJ 3 6773
73

A Trio of Navy Trainers

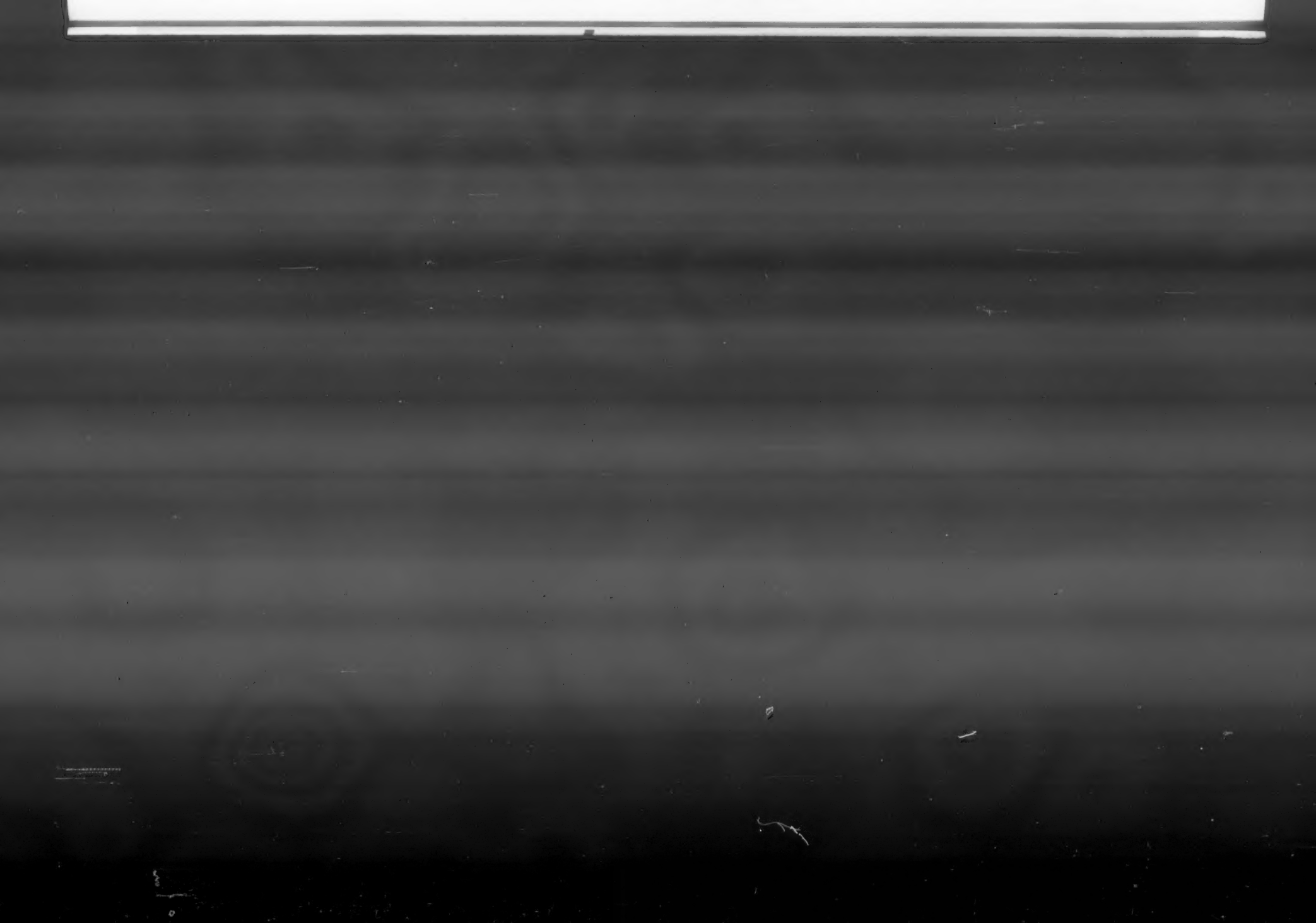
One of aviation's most colorful flight shots, a group of North American SNJ-3's in formation practice.

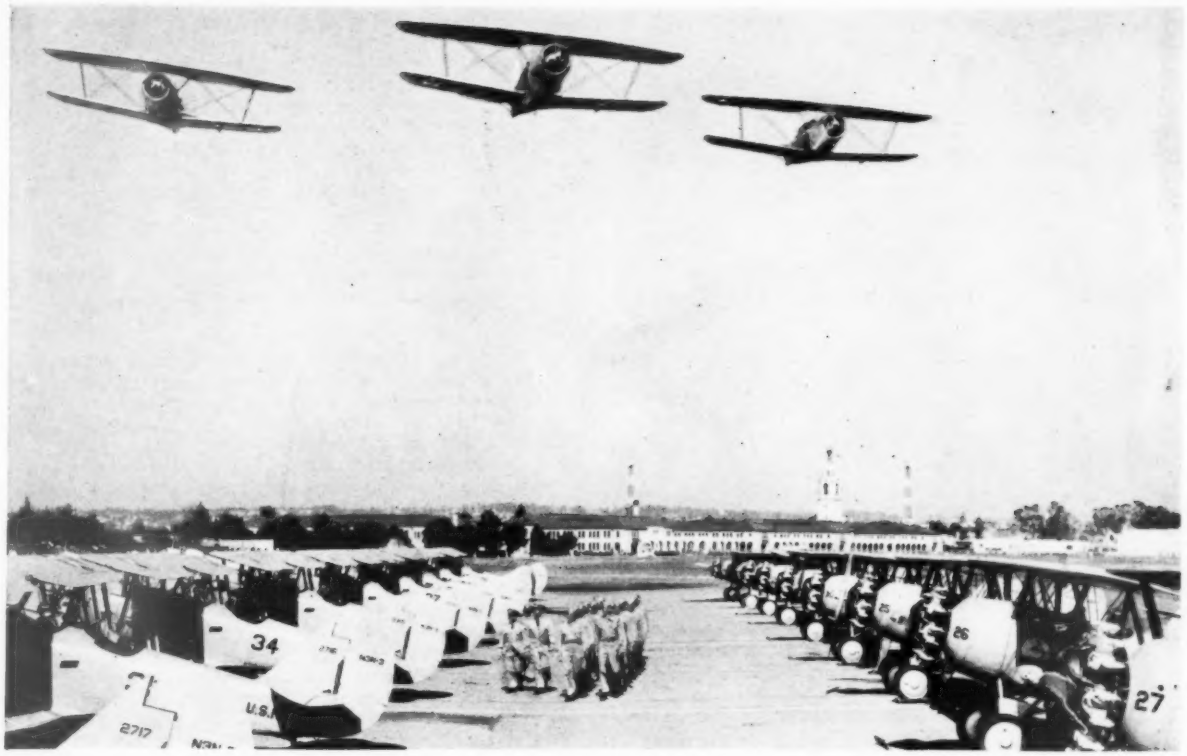
Naval Aviation

has a place for You...

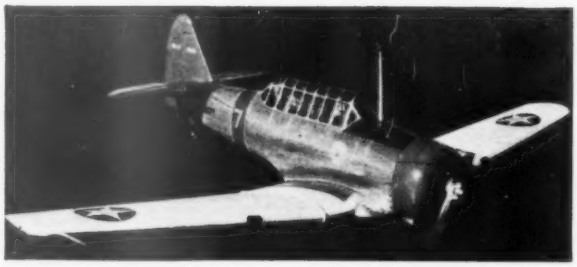
Pilots Machinist's Mates
Radiomen Metalsmiths
Ordnancemen

apply today





While Pensacola cadets march out to N3N trainers, advanced students fly overhead in Curtiss SBC-4's.

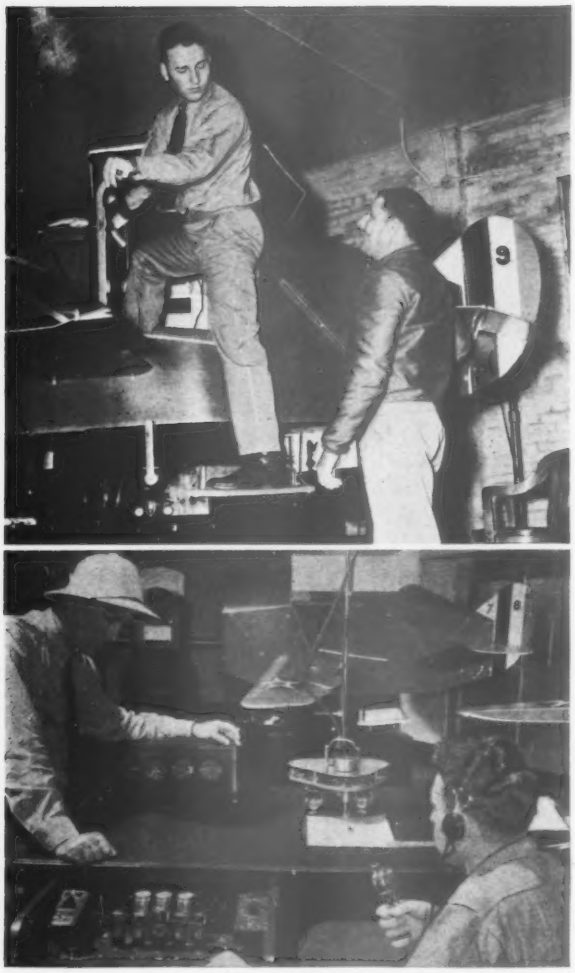


Advanced trainer, used largely for instrument flying, North American SNJ (AT-6 in Army) is popular with pilots as transport.

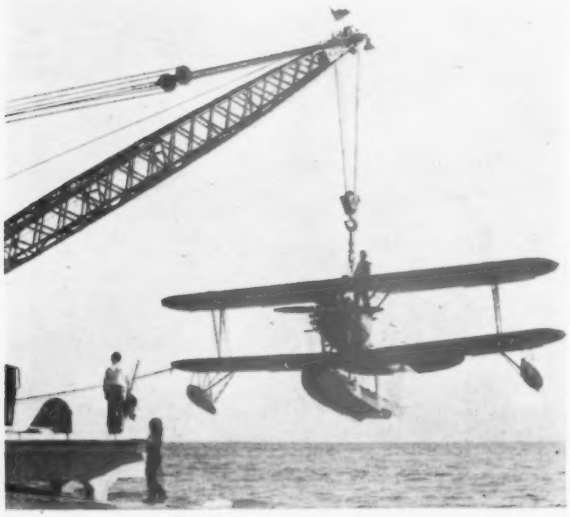
From primary trainers cadets advance to heavier planes, like the North American NJ-1. Basically similar to SNJ, it has fixed gear.

Obsolete patrol bombers, like this Consolidated P2Y-2, go to training bases to give cadets experience with that type plane.

Modern aircraft, like this Vought-Sikorsky OS2U, are sent to flying schools to give new Navy pilots practice for sea duty.



Navy uses famed Link Trainer for blind flying instructions. Fledgling (top) climbs in for test hop. Hood down, he "flies" blind while automatic recorder at desk traces his course.



Primary seaplane trainer at Pensacola is veteran N3N-3. Plane is launched down tilted ramp, later lifted ashore by derrick.

olis appointees, it is no small problem to imbue the many varieties of "Joe College" with Naval discipline, and mold them all into the pattern of the Naval officer. The brevity of the course, plus the fact that the majority of the cadets have not had previous military training, presents serious obstacles.

Roughly, the two-week indoctrination course consists of instructions in the fundamentals of Naval service, Naval command and procedure, Naval customs and traditions, Naval courts and boards, leadership, infantry, seamanship and good sportsmanship. This is definitely too much to be absorbed in so short a period. As much as is possible is repeated several times over during the remainder of the course.

Before the indoctrination course is over, each cadet has made the acquaintance of the station mascot—a bewildered and floundering duck, usually pictured in the first pains and tortures of flight. Symbolic of the Naval cadets and their first attempts to master the elements of air and water, he is the idol of them all and occupies a warm spot in their hearts.

Another acquaintance all cadets meet, more strenuous and exacting than the floundering duck, is the rigid 17 hour schedule in force at Pensacola. Before a day passes, they are convinced that the station is neither a college campus nor a country club, and that such college pranks as being late or cutting class are not tolerated. Quickly they adjust themselves to the rigid schedule of arising at 5:00 a.m., performing calisthenics before breakfast and reporting to their classrooms by 6:30 or to their squadrons well before 7:00. Even more quickly do they learn that they must work, and work hard.

Immediately following the two-week indoctrination course previously mentioned, each cadet begins his struggle with ground school academics. Lying in wait for him are six separate and distinct courses of instruction—power plants, structures, gunnery, communications, aerology and navigation. During the student's first four weeks in ground school, he spends eight hours a day in the classroom. During the remaining nine weeks of the course he spends three hours in the classroom and the balance of the day in the air.

Lectures, required reading in specially prepared textbooks, notebook work and tours of inspection of the huge Pensacola station acquaint the embryo aviator with such subjects as carburetion and ignition; engine theory, construction and operation; aircraft construction, accessories, materials and maintenance; aerial gunnery; aerodynamics; aerology; radio code; semaphore and blinker; radio and voice procedure; celestial and practical navigation; navigational instruments; plotting board; scouting and search and strategy and tactics.

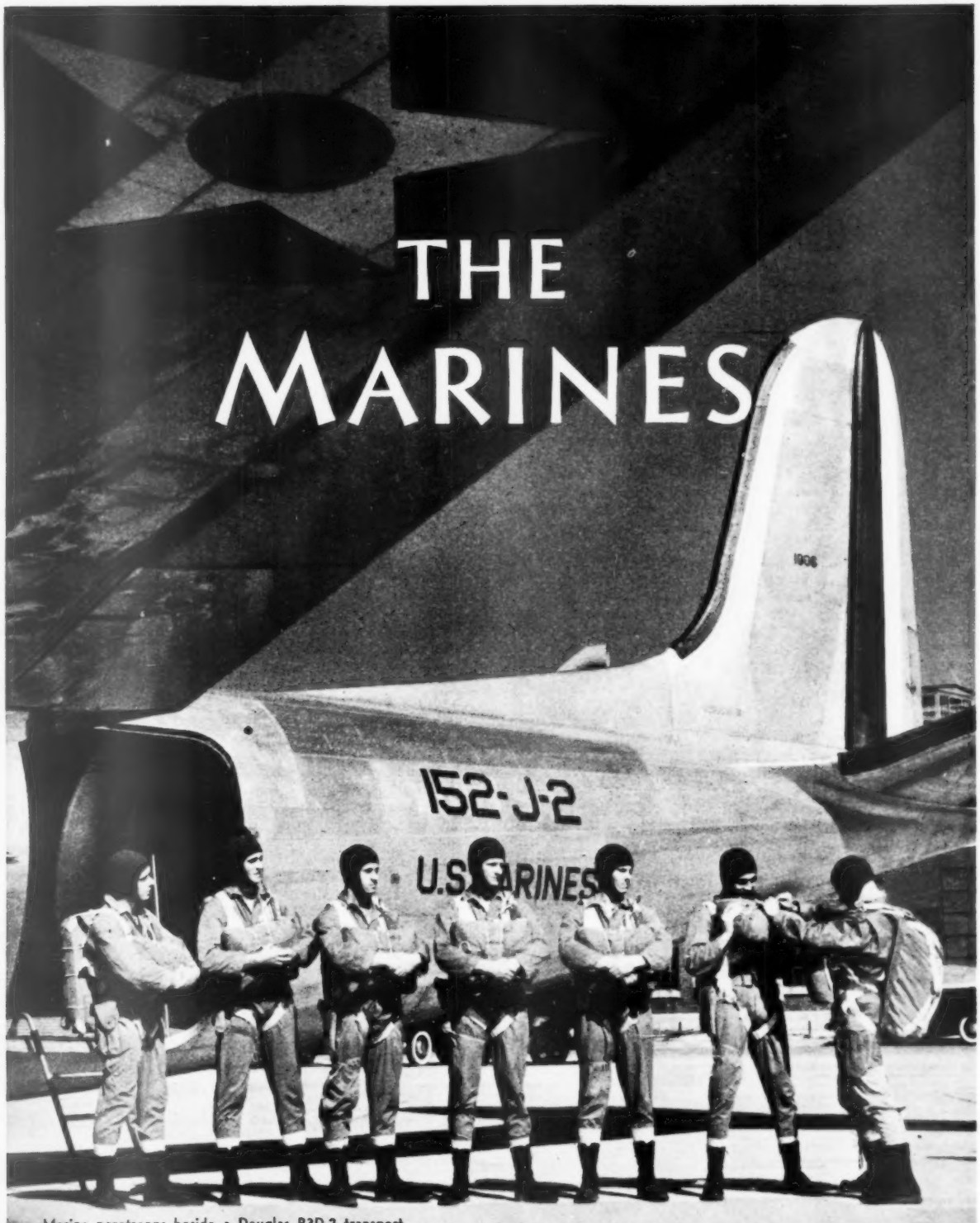
It is not enough that the cadet be exposed to these subjects; he must learn them and learn them well, for no Naval aviator is better than his knowledge of his job.

The ability to interpret the weather data at his disposal, proficiency in communications, and competence in establishing the position of his plane at any given moment, be it day or night, is absolutely essential. Incompetence in any phase of these all-around requirements may result in the loss of pilot and plane or the failure of a mission.

Coincident with the initial encounter with academics, the cadet is given a two-hour lecture by a flight surgeon on the subjects of high altitude flying and the dangers of "ear block," "blackouts" and "the bends." Following the lecture, he enters the station's "space ship," a steel-plated flightless flying machine resembling a large horizontal boiler from which air is extracted to simulate a climb of 2,000 feet per minute. Thus, without leaving the ground and while under the constant supervision of experienced flight surgeons, he experiences the sensations that come to one in rarefied atmospheres, and learns to appreciate all the more the value of oxygen as a requisite for stability. On returning to sea-level pressure at a rate simulating a descent of 2,000 feet per minute, the cadet, if his ears are not normal, suffers the discomforts of "ear block," which may be described as the result of the sudden build-up of pressure of the ear drums. In this manner, he learns what is to be expected when flying at and descending from high altitudes.

While the idea of a low-pressure chamber is not new, the Army, Navy and various research organizations having experimented with it for years, its adoption for training purposes is new. Pensacola was the first flight center in the country to adopt this procedure as a part of its training curriculum.

(*Continued on page 212*)



THE MARINES

Marine paratroops beside a Douglas R3D-2 transport.

Where the fighting is thickest, the U. S. Marines usually can be found. Marine airmen are some of the world's toughest, most capable pilots.

THE MARINES

by Col.
RALPH J. MITCHELL

Born in New Britain, Conn., and now the director of Marine Corps aviation in the Navy Department, Colonel Mitchell, in 1915, was graduated from the Naval Academy, then attended the Marine Officers' School, Norfolk, Va. He was awarded the DFC for service in Nicaragua in 1930. Prior to present duty, commanded 2nd Marine Aircraft Group, F.M.F., at San Diego, Cal.

THERE was a slogan at the beginning of World War I that thrilled many a youngster and has continued to be the ambition of a great number of young men. It was: "Fly with the U.S. Marines."

Back in 1913, Lieut. Alfred A. Cunningham, the first Marine officer to become a Naval aviator, was designated Naval Aviator No. 5. Following in quick succession were Lieuts. B. L. Smith, W. M. McIlvane and F. T. Evans. By the time war was declared, in April, 1917, Marine aviation consisted of four officers and 30 enlisted men. One organization was ordered to the Azores that year and the Day Wing of the Northern Bombing Group was sent to France in the summer of 1918. This group consisted of four complete squadrons whose commanders had less than four years of aviation experience. The pilots averaged less than 100 hours each and only one or two in each squadron had flown the DH's before they arrived in France.

Following the Armistice, Marine aviation faced the same struggle for existence that confronted the other air services. However, the Marines did have an advantage in that, during this period, service in Haiti, Santo Domingo, Nicaragua and China taught many lessons that now are paying dividends.

Nicaragua, in particular, was the proving ground for the close co-ordination which now exists between the air and ground forces of the Marines. In fact, one might believe that parts of the present German air force had served there, so closely does it follow the tactics of the Marines in that country.

Ground units were fed, clothed, paid and otherwise supported by air. Air support was available on call and, by the use of panel messages from the ground, aerial *blitzkriegs* were initiated upon hostile elements critical to the safety of our own ground troops. Excellent team work resulted and today that jungle experience is being utilized in the most modern weapons.

The primary mission of Marine aviation is the support of the Fleet Marine Force. The latter organization is a mobile, seagoing, fighting force, composed of Marines particularly trained to effect landings wherever required. Special technique is necessary for the aviation force supporting a landing on a hostile shore. Perfect air co-ordination with the Navy and with the landing forces is absolutely necessary and can only be attained through repeated practice.

Marine air squadrons also act as replacement units for aircraft carriers. Naturally, these squadrons must be thoroughly trained in all aspects of aircraft carrier operations. This training is so extended that all pilots of the present Marine squadrons are carrier qualified. Opportunity is also afforded periodically for new pilots to obtain this training.

The possibility always exists that Marines may be called upon to operate far inland in regular land warfare and this eventuality calls for an entirely different type of training for the small but versatile air force. Although air objectives in this case will differ greatly from those found in landing operations, again co-ordination with ground forces is most important.

There are three classes of pilots utilized by Marine aviation: officers of the regular service, reserve officers and enlisted pilots. A limited number of regular officers are selected each year. They have usually had from two to four years service with the ground forces of the Marine Corps and average approximately 25 years in age. The experience gained through association with the ground forces is extremely valuable. Officers so indoctrinated have obtained knowledge of ground tactics, the capabilities and limitations of the various arms, as well as a clear picture of where aviation fits into the different operations.

A very large percentage of Marine Corps pilots are, and will continue to be, reserve officers. Applicants for flight training in the Navy or Marine Corps are given an elimination training course at one of the Naval Reserve bases. When the applicant successfully completes this course and subsequently graduates from one of the aviation training stations, he is given the choice of accepting a commission as ensign in the Naval Reserve, or 2nd lieutenant in the Marine Corps Reserve. Eighteen months after completion of flight training, Marine Reserve officers are given the opportunity of qualifying for a commission in the regular Marine Corps.

A number of enlisted men are also selected each year for flight training. They, too, go through the Naval training centers at Pensacola, Jacksonville or Corpus Christi.

The Marines do their share of administrative work in the Navy's vast air training program. Marine instructors are on

Not always the case in past years, the Marines now have first-line aircraft. These Grumman F3F's now are being replaced with newer "Wildcats." Squadron markings on fuselage are same as Navy, with "M" added.

duty at each Naval Reserve aviation base. Over 100 Marine instructors are stationed at the training centers. Marine pilots are also attached to the Bureau of Aeronautics and to the Navy test sections at Philadelphia and Washington where they are engaged in the preparation of new types for the operating squadrons.

As a part of the Navy's 15,000 plane program, the Marines are to have two air wings, each to be attached to a Marine division. Each wing will be divided into five air groups of several squadrons each. The wing is directly under the command of the division commander and all air units within the wing will work for, and with, the division to which attached.

Each group will have, in addition to its tactical squadrons, a headquarters and service squadron. This, as the name implies, is truly a service unit, equipped with portable shops and sufficient equipment and spare parts to do the upkeep and repair work which is beyond the scope of squadron personnel. This unit contains many specialists not usually found in tactical units, such as aerologists, ground communication experts and photographers. This organization is considered essential in order that the group may be entirely self-sufficient when operating independently.

Supplying an aviation wing or group is a problem of utmost importance and one that is becoming more and more complex. More power is being built into engines, electrical systems are more elaborate, new instruments are being added, more radio equipment is being installed and many planes are now being equipped with automatic pilots. This means that the number of spare parts on hand is increasing and that fuel must be provided in greater quantities. All effort is completely wasted if the airplane is out of commission due to the lack of certain parts, or if fuel is not available at the place and time needed, or if bombs and ammunition are not on hand. The Marine Corps supply organization is being expanded with long-range plans formulated to insure that adequate supply keeps pace with the contemplated expansion.

All aviation material used in Marine aviation is procured by the Navy. In general, the same types of airplanes are assigned as those allocated to Navy units. Tactical squadrons have a similar organization. Radio, ordnance equipment and motor transportation is identical with that of the Navy.

In order that co-ordination may be properly effected, a Division of Marine Corps Aviation is set up in the Bureau of Aeronautics of the Navy Department. This division has the dual function of advising the chief of the Bureau of Aeronautics on Marine Corps matters and the major general commandant of the Marine Corps on aviation matters.

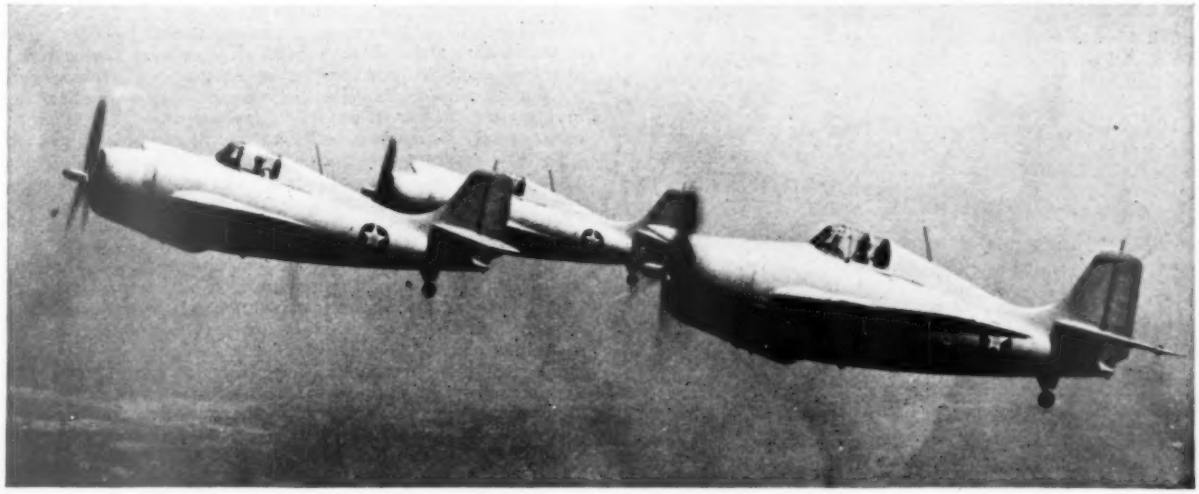
Marine aviation is charged with the operation, maintenance and overhaul of its airplanes, engines and equipment. Two large overhaul bases are provided, one on the east coast and one on the west coast. Each base is supplied with complete shop equipment and trained personnel.

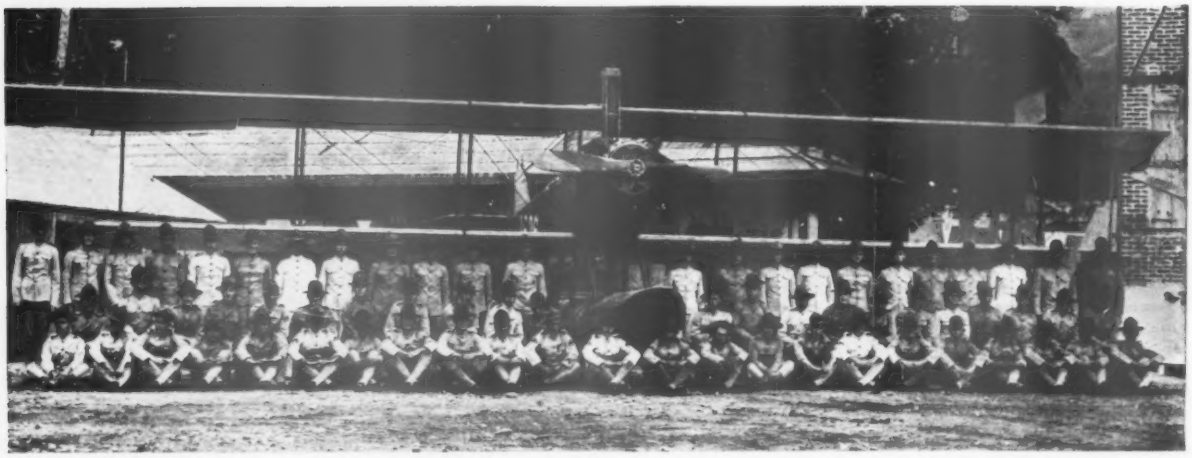
Several thousand enlisted men will be taken into Marine avi-

Marine aircraftsmen, like the pilots, are trained in Navy schools. Pratt & Whitney engines above have corrosion-proof cylinders.

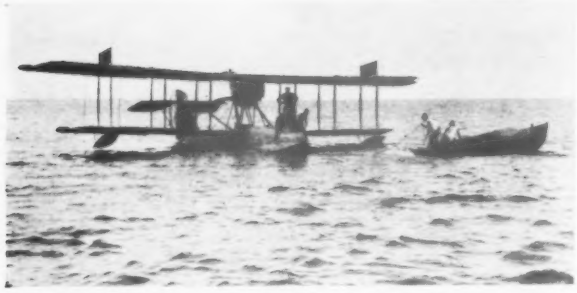
This machine shop contains elaborate equipment for maintaining aircraft. One big Marine overhaul base is on each coast.

Grumman "Wildcats" (F4F) are latest fighters. Marine aircraft are identical to Navy types; markings are limited to rudders.

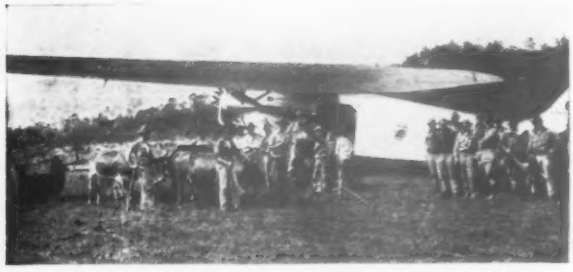




One of the Marines' pioneer aviation units included this group, photographed in Haiti in 1920. Plane is a version of famed Jenny.



Used primarily for patrol and reconnaissance, this old Curtiss flying boat was on duty with Marines in Caribbean area in 1920.



This tri-motored Fokker transport carried supplies to Marine mounted patrol in Nicaragua. This was during fighting in 1929.

Highly individualistic squadron markings, like those on 1932 Curtiss biplanes below, have been banned. Note two wing guns.

ation this year and each must become proficient in his specialty in order that new units to be organized may function efficiently. In this connection, the field of the enlisted man's specialty is very diversified. There are 48 separate classifications of duties which must be performed by enlisted men.

An important adjunct of Marine aviation is the intensive parachute training program that has been under way for some time. There are now a number of units thoroughly trained, indoctrinated and equipped for active service.

Marine parachutists are young, in perfect physical condition and absolutely fearless. They volunteer for this duty and are thereafter most carefully selected. The necessity for high qualifications is quite apparent when it is considered that the parachutists may be the spearhead of an attack, and its success may well depend entirely upon this group.

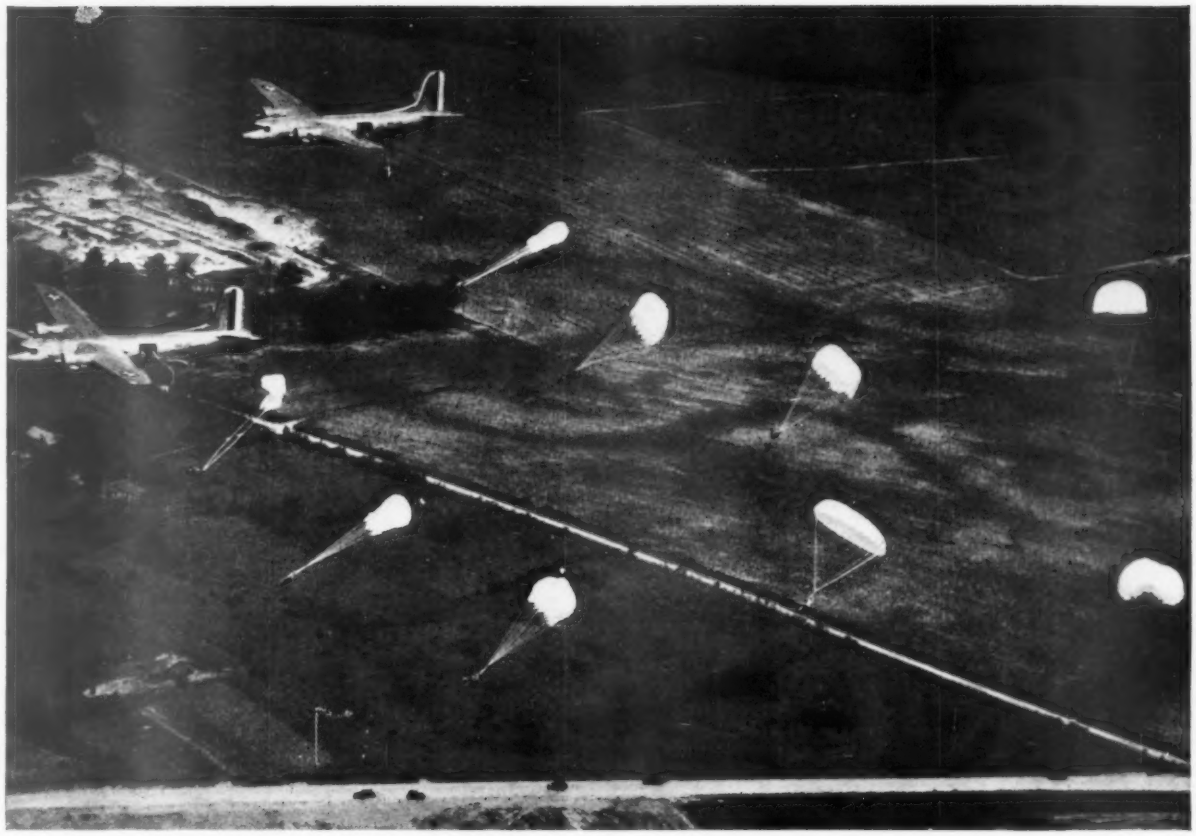
Air-borne infantry has likewise been given considerable thought. Delivery to destination is normally accomplished in three ways: by landing on airdromes in transport airplanes, by jumping from transport planes with parachutes and by landing at the objective in gliders. Training in the first and second of the above methods is now being emphasized by the Marines and facilities for the third method will soon be available. A glider program has been initiated which, when completed, will insure that Marine fighting forces are as mobile as it is possible to make them. Since they are in reality "soldiers of the sea" and trained to operate as part of the Navy, something new in gliders is being developed for this force. All troop carrying gliders are to be amphibious, capable of operating either on land or water. This feature is expected to provide a decided advantage in localities where landing fields do not exist.

The Marines have also been given the job of organizing and training balloon barrage units for the protection of Navy and Marine shore establishments. Barrage balloons are also used in the vicinity of important objectives to prevent low altitude dive bombing. Scattered at various altitudes and anchored in position by wire cables, these balloons are extremely effective in diverting attacks from the immediate area. Striking a cable usually means destruction of the plane.

For this program, the Marine Corps has been authorized to establish eight squadrons of barrage balloons, each comprising about 30 balloons with adequate reserves and equipment. In addition, a balloon training school has been established at Parris Island, S. C.

The present problem of effecting an expansion of 400 to 800 per cent in both air and ground crews within the next year or two, is one of considerable magnitude. It will mean that young officers of three to five years' service will be leading squadrons and that crews which lack the experience of the more seasoned veterans will have to take over. However, these younger men are filled with ambition, energy and imagination; and they are possessed of the intelligence to rapidly cope with the situation.

At the moment, to Marine aviation, as to all other military air organizations, time is of the utmost importance. The many



services, tactical and technical, which must be quickly multiplied and expanded present training and procurement problems which tax the ingenuity of all. In such an expansion, it is definitely known that the veneer of experience will be thin. Such being the case, every effort is being employed to make every minute count.

EDITOR'S NOTE—The history of the U. S. Marine Corps, which is the military branch of our Naval service, dates back to the passage of a resolution by the Continental Congress on November 10, 1775, authorizing the organization of two battalions of Marines. Since that date the extremely varied service on land and sea, which is characteristic of the Corps, has been performed in a manner which is reflected in the high *esprit de corps* of its personnel and the pride in the organization. The entire history of the Marine Corps is one of active service: afloat in the combatant Naval vessels of the Fleet, and ashore in the furtherance of Naval missions or in service with the Army.

During the Revolution, the Marines took part in all Naval engagements participated in by the commands of Commodore Esek Hopkins and John Paul Jones; performed their characteristic duty of conducting landing operations in the capture of Nassau and New Providence Island in the Bahamas; and distinguished themselves while serving with Washington's army in the battles of Trenton and Princeton and in the subsequent engagements of that war.

The Naval war with France from 1798 to 1801, and the war with Tripoli from 1801 to 1805, found the Marines taking an active part. During the War of 1812 they served as guards on almost all of our Navy vessels. The Marine guard of the *U.S.S. Constitution* took an especially prominent part in all her great battles. The Marines shared in the victory of Lake Erie and performed with notable effectiveness when serving with the military forces in the invasion of Canada. There were Marine units with the troops which took part in the defense of Baltimore and the battle of Bladensburg.

From the war of 1812 to the Civil War the history of the Marine Corps is one of action, both on land and sea. Marines

A major function of Marine aviation today is the organizing of paratroops. Marines above are jumping from Douglas R3D-2 transports. Jumper's main chute (below) is opened automatically.

Vought-Sikorsky JRS-1 is a Marine utility amphibian. Markings on nose stand for First Marine Utility Squadron, Plane No. 4.

took part in the fighting with the Indians in Florida, and the destruction of pirate strongholds in the Caribbean. They assisted in the capture of Vera Cruz and formed part of Scott's column in the march on Mexico City in 1847, as well as participating in other engagements of that war. Marines also took a prominent part, both on land and sea during the years 1845-1847, in connection with the conquest of California. During the Civil War Marines served afloat and ashore in Naval operations against confederate coastal defenses and in the Mississippi valley. For many years subsequent to the Civil War, a time which marks an inactive period in our Naval and military history, the activities of the Marine Corps were confined to what may be described as peacetime operations at Naval stations and on board Naval ships, with an occasional expedition to some disturbed area to protect American lives and property.

During the Spanish-American War Marine detachments saw active service afloat, as well as ashore, in Cuba and the Philippines, both during the war and later in the pacification of disturbed areas. The Boxer Rebellion found them taking part in the defense of the Legation Quarter in Peking and later furnishing a regiment in the relief column. Since that time, with the exception of the brilliant record made by the Fifth and Sixth Regiments of Marines in France, when serving with the Army as units of the Second Division, the Marine Corps has been busily occupied by various duties on ships of the Fleet, and its characteristic role as the military arm of the Navy. The Corps has taken part in some 35 expeditions, protecting American lives and property in many parts of the world. It has successfully intervened in the civil strife in Santo Domingo, Haiti and Nicaragua during the present century and though having withdrawn from these countries at the present time, the stable governments which it established are still maintained, and the public health facilities, schools, roads and public works undertaken during this period in those countries remain a monument to our civilization.

Marine sergeant-pilots are capable enlisted men. This sergeant signs required "yellow sheet" before leaving on mission in SNJ.

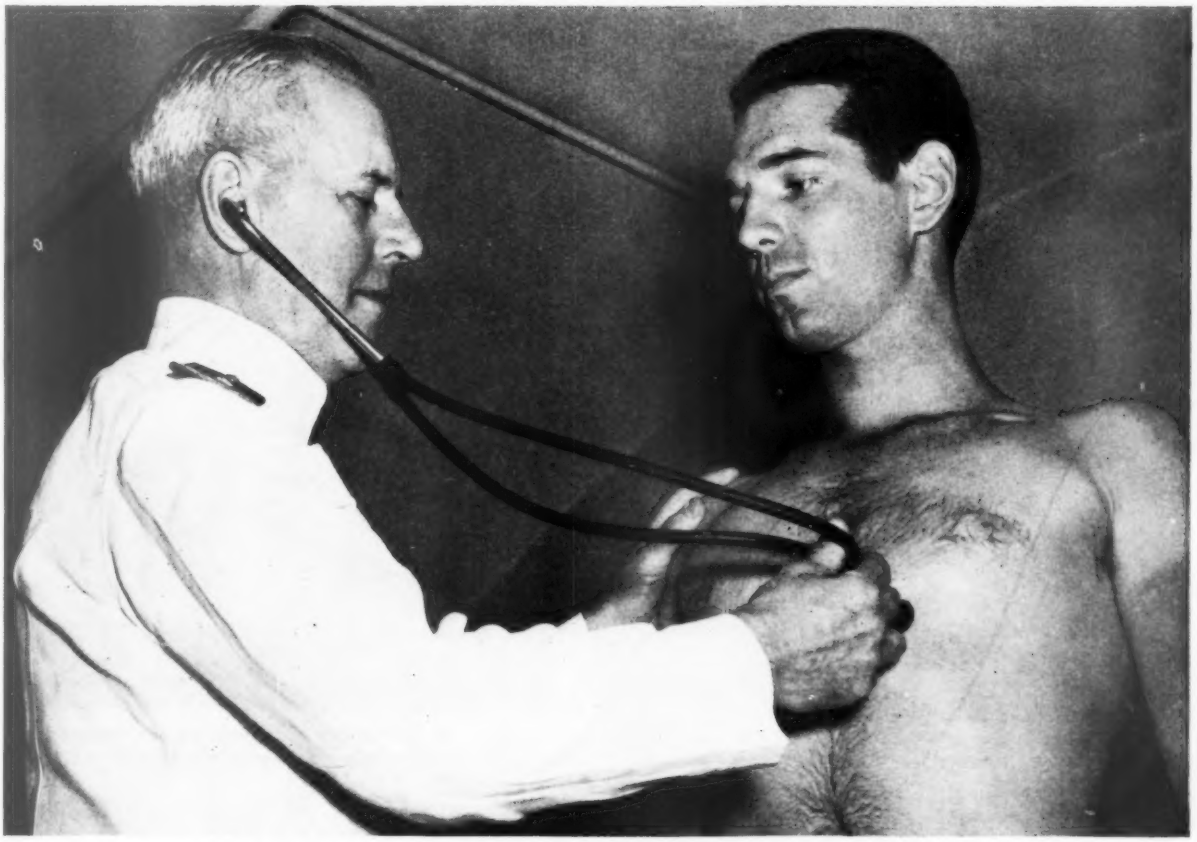
Marine detachments form a part of the complement in all of our battleships and aircraft carriers, heavy cruisers, and in the later type light cruisers, as well as other types of combatant ships performing duty in those areas where Marines may be used. These detachments furnish gun crews for the secondary batteries, the antiaircraft guns and machine guns, as well as a nucleus for the landing force organization in the ships. Members of these detachments serve as instructors in the use of infantry weapons used by the landing force and perform a part of the guard duty aboard ship. In this way Marines become familiar with life at sea and the methods, customs and traditions of the Navy. The Marine officers serving on the staff of commanders of larger units in the Fleet are given an opportunity to become familiar with Naval tactics, the capabilities and limitations of the Fleet, and the role of the Marine Corps as an organized military arm of the Navy.

Our national defense policy, both present and past, has opposed our acquiring territory for, and the building of, Naval bases at strategic points throughout the world. In time of war, therefore, for our Fleet to operate effectively and to maintain itself far from our home shores will require the rapid seizure and effective defense of advance bases from which the Navy may operate. The organization maintained for this duty by the Navy is called the Fleet Marine Force and is an integral part of the United States Fleet.

The duty performed at sea by Marines serving in the combatant ships of the Navy develops and trains a source of personnel for the Fleet Marine Force which is familiar with the sea as well as trained in the tactics of land warfare. The troops regularly assigned to the Fleet Marine Force are normally stationed at the two larger Marine Corps posts—the Marine Corps Base, San Diego, Cal., and the Marine Barracks, Quantico, Va. The Headquarters of the Fleet Marine Force is at San Diego, and at each of the above Marine posts there is maintained a reinforced brigade of reduced strength, consisting of an infantry regiment, a battalion of light field artillery (pack howitzer), a battalion of antiaircraft artillery, an aviation group, a light tank company and small contingents of engineers and chemical troops. The aggregate strength of the Fleet Marine Force is now 4,800 officers and men, and this is gradually being augmented as the strength of the Marine Corps is increased. The units of the Fleet Marine Force are kept constantly trained for their specialized duties by annual maneuvers with the Fleet, or with portions thereof, as well as being trained at home.

The Navy afloat cannot operate without a vast outlay of shore establishments. It, therefore, maintains within our own continental borders numerous shore stations such as Navy yards, munition manufacturing plants, ammunition depots, storage depots and training stations. At these Navy shore establishments approximately 4,000 Marines perform much of the guard duty, watching over property valued at over a billion dollars. Though the duty of the Marine Corps personnel serving in this vast outlay of Naval shore establishments is primarily guard duty, at the same time every Marine so serving is kept constantly trained for war service, both afloat and ashore. Even at those stations where the detachments of Marines are very small, training is continued in various forms of individual instruction, as well as such group training as the limited number of men will permit. This sys-

(*Continued on page 244*)



Man's own power plant—his heart—must be in perfect condition to get by Navy's stethoscope.

The Naval Flight Surgeon

Combination Dutch uncle and father confessor to pilots, the Navy doctor selects trainees and keeps them flying.

by Capt. J. R. POPPEN

Born in Forest Grove, Mich., May 18, 1893, and a Naval officer since 1917, Captain Poppen served in Haiti with the Marines before being detached to school of aviation medicine at Mitchel Field, N. Y., in 1922. In 1925, was assigned to duty as flight surgeon, Battle Fleet. Took postgraduate work at Harvard in 1932. Now is attached to Bureau of Aeronautics' medical research unit.

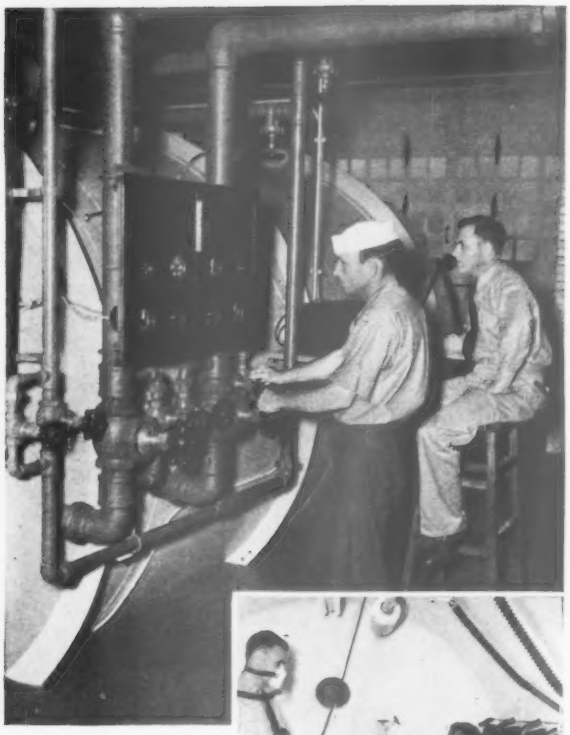
AVIATION medicine is primarily preventive. The military aircraft of today are exceedingly complex mechanisms. They operate at extreme speeds, have excessively high ceilings and increasing maneuverability. They are equipped with a maze of instruments, controls and ordnance gear.

During the World War the big problem was how to get the most out of aircraft. Today, when performance of military aircraft exceeds the physical capacity of the average man, the problem is how to get the most out of the pilot.

The tempo of Naval aviation has speeded up to such an extent that the strain is tremendous. Pilot personnel must be as perfectly selected as possible. Once in the service, any dropping below the established high norm must be discovered and corrected. As mechanical strain places new and different stresses on the human element in aviation there must be continuous research to combat this challenge. Thus the task of the Naval flight surgeon, combination Dutch uncle and father confessor to the men in the planes, is to—"Keep them in the Air."

The duties of a Naval flight surgeon are embodied essentially in three main fields of activity. First is the selection of applicants for aviation training and the further selection for special kinds of flying. Second is the maintenance of that degree of mental and physical fitness which is required throughout the career of the Naval aviator. Third is research into better methods of selection and the discovery and development of better means of preserving that degree of fitness.

Meticulous care must be taken at all times in choosing the candidates for Naval aviation. All technical and professional ability at the flight surgeon's command is exercised to preserve standards compatible with the hazards of flying for the Navy. Cardinal point to be considered in the selection of student aviators is "will he be qualified in all respects to meet the requirements for Naval service?"



Pensacola's "space ship" gives cadet high altitude experience under watchful eyes of medicos. Controls (above) extract air from chamber (right) simulate 2,000 f.p.m. climb, dive, Doctors check reactions.

Known as Schneider Index, circulatory test above shows pulse reaction to series of alternate exercises and rests.

It must be certain that he is free from disease or disability which would disqualify him from the general laws applying to commissioning and retirement. If he is basically sound in this respect, he must then meet the physical requirements peculiarly applicable to flying.

At this point, two important items must be considered. There are certain physical and mental defects or deficiencies which militate against keeping alive in flying. For example, a person with defective vision is more likely to crash than one with perfect eyesight. In requiring freedom from such defects, the flight surgeon acts in his purely professional capacity of saving life and preventing injury. Second, it is not sufficient to determine that an applicant is physically qualified to fly at the moment. It is necessary also to determine whether he will continue to qualify for five, 10, 15 or more years from the date of examination. This, realistically, is a matter of sound investment.

In determining the special physical and psychological qualifications for Naval aviation, it should be borne in mind that not everyone who can fly an airplane is necessarily qualified to be a Naval aviator. Actually, the manipulation of the controls for successful flight by the flyer constitutes only a mode of locomotion. The analogy may appear far-fetched but in many respects the Naval aviator is quite like an infantryman. The latter uses walking as his mode of locomotion to place himself in a position from which he can advantageously carry out a military mission. The Naval aviator does precisely the same thing when he flies his plane. Just as the infantryman must relegate his mode of locomotion to an automatic instinct which permits him to give absolute attention to the specific mission at hand, the Naval aviator must do the same thing with his actual flying manipulations.

Unless an applicant has the physical and temperamental make-up which permits him to learn the manipulation of his controls to a similar degree of automaticism, he will find it necessary to apply a considerable part of his attention to this detail and will consequently have less time for the specific mission. Unless he has these qualifications, he should not be accepted for training in Naval aviation.

Once the candidate becomes a student aviator, the close relationship with the flight surgeon continues. As a Naval aviator he is entering a field that includes certain well defined hazards. This applies not only to the strain of long extended flights in the patrol bombers, but also the strain of long and frequent standby periods on the part of the carrier pilots.

The two examples cited are very divergent types. They require different types of personality. Pilots must be selected for their ability to withstand the rigors and special demands in either type.

The manner in which a pilot will evidence strain or incipient strain varies with the type of flying and the peculiar configuration of the pilot himself. The flight surgeon must be alert to all these variabilities. His role is one of physician-advisor. He must know his pilots intimately, live and move in their company. He must be alive to their individual personalities in order to estimate and judge the slightest variation from normalcy. Whenever this occurs an attempt is made to eliminate the cause and correct the difficulty wherever possible.

In many cases correction is simple. Slight changes in assignment, leave, or more protracted separation from the ardors of operational flying will suffice. Correction of mild physical disabilities or dietary inadequacies may restore that degree of composure and compatibility necessary to preserve the flying fitness of a specific pilot.

Since the cardinal principal of aviation medicine is prevention, the flight surgeon must be intimately acquainted with the peculiar requirements of the missions to which his pilots have been assigned. In this way, he will be better qualified to make recommendations for leave, recreation or changes in

Any turning chair can be used in orientation test. Spun right and left, cadet must state direction he then faces.

Pulling the string back and forth, pilot must align rods in lower panel 20 feet away, to pass depth perception test.

routine which will prevent the progress of incipient strain.

A flight surgeon's usefulness is in direct proportion to what he knows about the problems analogous to flying. In order to analyze and prescribe for his pilots he must be familiar with the types of flying to which they have been assigned. It is not necessary that he be qualified as a Naval aviator. Furthermore, it is quite possible that proficiency in this activity might prevent the full and complete exercise of his professional medical qualifications. On the other hand, he must fly. It is just as impossible for a flight surgeon to be keenly alert to the requirements of his professional charges without flying as it would be for a medical officer assigned to cavalry to be competent to advise in physical fitness measures if he were not competent in equitation.

Nothing will do more to establish the rapport between the flight surgeon and his pilots than the willingness to accompany them on any and all of their flights. In order to adjust himself to their daily conversations and to live with them in their routine, he must be conversant with the details of their peculiar professional requirements. For this reason provision has been made for flight surgeons to make repeated and frequent flights in all types of aircraft.

To further the effectiveness of preventive medicine continuous research is conducted in an effort to halt accidents before they occur. Not the least of these research fields is the improvement of the means of supplying oxygen for high altitude flying. This means the development of individual oxygen breathing apparatus, multiple installations for the various aircraft and atmospheric hygiene involved in the development of pressurized cabins and suits. Concurrently, as the performance and ceiling of aircraft increase, the need for this equipment increases.

There are aircraft in service today that can attain altitudes exceeding the normal physiological ceiling of a considerable portion of pilots. It is necessary, therefore, that we select pilots with particular capacity to operate at these excessive altitudes. This ability is based first on the capacity to withstand meager oxygen supply. As the rates of climb and endurance at high altitudes increase, the selection must also be based on the pilots susceptibility to bends or aeroembolism.

There is also need for continued research into means of obviating the effects of high acceleration, commonly known as "blacking-out." This often occurs in pulling sharply out of a dive or in turns of short radius. There is need for selection of pilots on the basis of their ability to distinguish forms under reduced illumination, so-called night vision. In this connection, research extends into developed means of illumination, elimination of glare, dietary considerations that may aid vision and the administration of oxygen to insure efficient night operations.

The flight surgeon's task entails all these and many other items. He is constantly seeking development of better methods in selecting student aviators, improvements in comfort and protection against injury under normal operating conditions. There is the need for increased and more practicable knowledge concerning the use of drugs and vitamins to maintain efficiency or to relieve the symptoms of fatigue. Into the focus of the ever probing flight surgeon come, in addition, such items as clothing, goggles, anti-glare glasses, night glasses, emergency rations and water.

The flight surgeon is an integral part of Naval aviation. He is a physician, commissioned in the regular Medical Corps of the Navy.

After a period of regular service in this Corps, which includes at least one cruise at sea in regular medical activities, he is given special instruction in the subject of aviation medicine. This instruction is divided into three essential parts. He is given didactic academic instruction in aviation medicine. Next, he is given a course of indoctrinational flying which is designed to familiarize him with the various types of flying activities in the Navy. Finally, in order to be fully qualified as an efficient flight surgeon, he must complete a tour of duty with a unit of the aeronautic organization of the Navy.

Flight surgeons are, as are all of the personnel of Naval aviation, volunteers, and have precisely the same end in view as the pilots and other technical advisers.

Their particular function is to exercise and practice their specially trained ability toward preserving that degree of personnel fitness that has earned Naval aviation the reputation of being the best trained, most efficient unit of its kind in the world.

END

LIGHTER-THAN-AIR

The non-rigid Naval airship G-1 being secured to its mast at Lakehurst, N. J.

Despite many setbacks with dirigibles like the Akron and Macon, the U. S. Navy today operates one of the largest fleets of airships in the world.

by Comm.
S. E. PECK

Associated with lighter-than-air craft since the time of the DN-1, first Naval airship, Commander Peck has survived five crashes including that of the *Macon*. Born at Cozad, Neb., October 24, 1895, entered Naval aviation in 1917, flew non-rigids on North Atlantic patrol in World War I. Prior to present duty as head of the airship division of the Bureau of Aeronautics, Commander Peck was Naval aircraft inspector at Akron, O.

ALL aeronautics is divided into two parts, one of which is called "lighter-than-air" and deals with craft that float in the air; the other part is called "heavier-than-air" and deals with craft that stay aloft by the dynamic forces upon their wings, resulting from their speed of flight through the air.

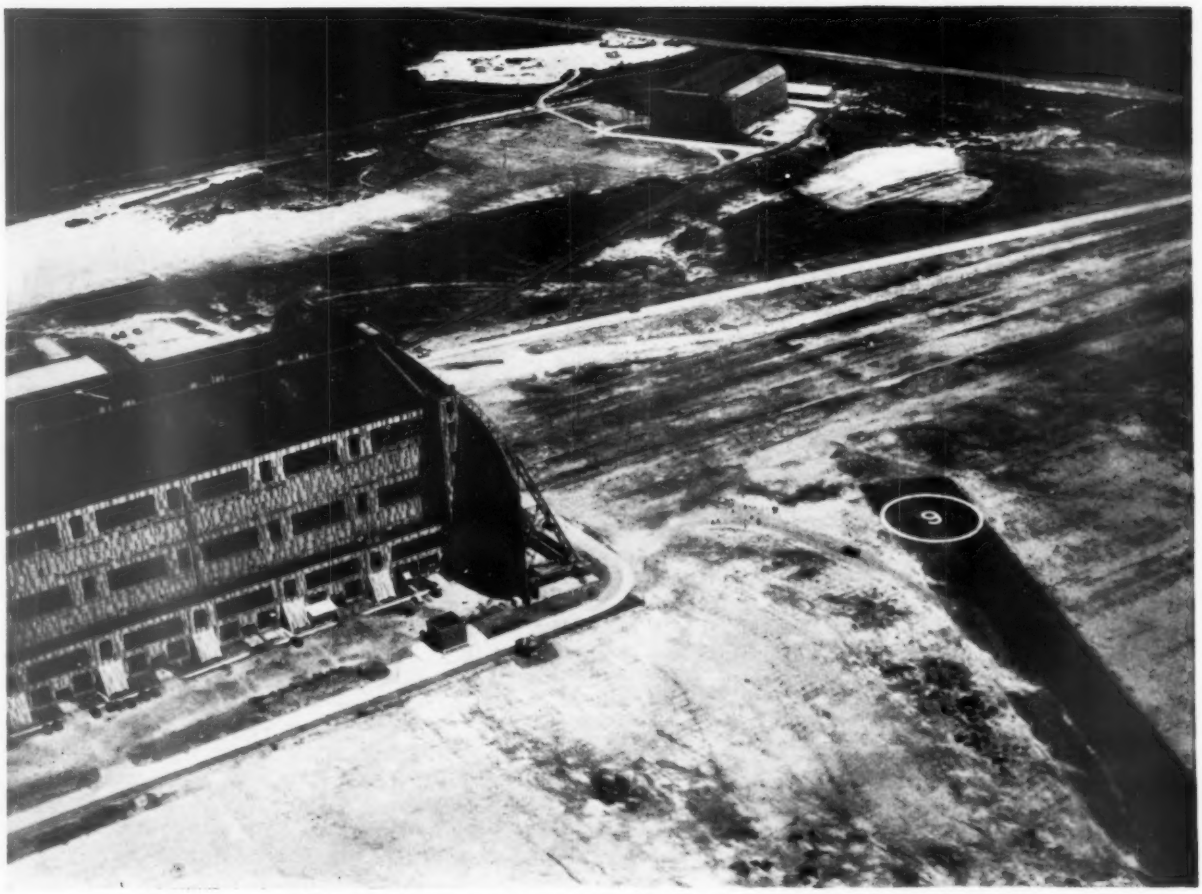
The first man-carrying lighter-than-air craft was the hot air balloon of the brothers Montgolfier, which made an ascent near Versailles in 1783. Less than a month after this historic event the first man-carrying balloon to be inflated with hydrogen made a successful flight of about 30 miles in two hours.

For nearly a century and a quarter after these first balloon flights, lighter-than-air made only slow progress, and heavier-than-air was not yet born. Then, about 1900, the lightweight gasoline engine began to revolutionize the world's transportation. It turned lighter-than-air craft from drifting balloons into true ships of the air, and brought heavier-than-air into existence. It is hardly too much to say that modern aeronautics is the child of the gasoline engine; but this is much more true of heavier-than-air which depends upon the engine for sustentation as well as for locomotion, than for lighter-than-air which requires the engine for locomotion only. This fundamental difference in the two branches of aeronautics explains the marvelously rapid growth of the younger branch in the past 30 years.

The great development of aviation engines was relatively far more beneficial to airplanes than to airships. In 1914, the airplane was only slightly faster than the airship. In endurance, lifting capacity and maximum altitude the airship was far ahead of the airplane. Until the last year of World War I, airships were the only German aircraft capable of bombing England. In 1941, powerful and reliable engines have given the airplane an overwhelming advantage in speed and altitude; and only the very large rigid airship retains for lighter-than-air a superiority in load-carrying capacity and endurance.

There remains for lighter-than-air one unique advantage which, in the nature of things, it is not likely to lose—the ability to hover or stand still with little or no expenditure of mechanical power. We shall investigate the possibilities behind this unique quality.

In World War II, the only lighter-than-air craft yet used by any of the belligerents are barrage balloons. These have been



Blimp hangars at Lakehurst are seen from a free balloon which had just taken off from circle (center right).

employed in great numbers and are declared by those who should know best to be an absolutely essential part of anti-aircraft defense.

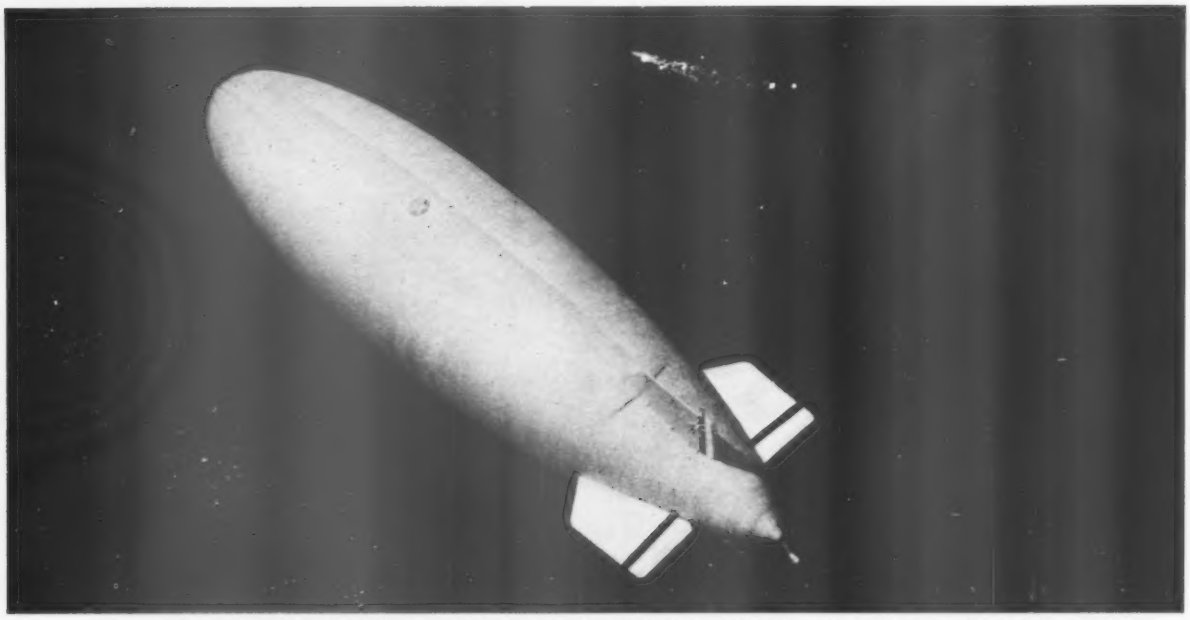
The modern barrage balloon has a streamlined envelope, made of two-ply fabric, with rubber or a synthetic substitute to bind the plies of cloth together and to provide gas-tightness. The balloon is usually about 80 feet in length, and 20,000 to 27,000 cu. ft. in volume when fully dilated. To keep the balloon always tight and in streamline shape, in spite of variations of the gas volume with changes in altitude and temperature, elastic cords are provided to contract the envelope transversely and thus maintain positive internal pressure in spite of diminishing gas volume. These elastic cords take the place of the air pressure ballonets used in rigid airships, and in the kite balloons of the last war. Large fabric fins, inflated with air or gas, are used to stabilize the balloon in the air.

Barrage balloons are usually flown at altitudes of 7,000 to 8,000 feet. They are ineffective against indiscriminate high-altitude bombing of cities, but they are a powerful deterrent to the low-altitude dive bombing which is necessary for effective aim against military objectives.

Kite balloons, rather similar to barrage balloons in external appearance, but 50 to 100 per cent larger, were used extensively in the last war to carry observers aloft behind the lines of trench warfare, and also for gun spotting on surface ships. This branch of lighter-than-air activity is no longer considered to be of practical value. Observation balloons on land are too vulnerable to airplane attack and at sea they hamper the movements of the towing vessel, especially so if any regard is paid to protection of the observer against mal-de-mer from the violent motion and jerks on a kite balloon towed by a vessel maneuvering at sea.

In World War I great use was made of airships for bombing, scouting, mine searching and anti-submarine patrol. A famous

A patrolling blimp circles over a freighter at sea. Navy lighter-than-air craft fly regular patrols over the Atlantic.



An Atlantic-patrolling Navy blimp spots the wake of a submarine periscope, later identifies it as U.S.S. S-29.

Bunks above are for crews' relief during long flights. Navigator below works at special desk directly behind the cockpit.

flight, showing the transport value of airships, was made by a German rigid airship from Bulgaria to German East Africa and back, carrying supplies which were not landed in Africa because the colony surrendered to the British just before the airship arrived.

In World War II, none of the belligerents have so far used airships, but does this mean that the airship is obsolete for military and Naval purposes? The answer may be "yes" for countries which have no helium, and whose airship bases would be within easy bombing range of enemy airplanes. It is most assuredly "no" for the unique situation of the United States which contains the world's only appreciable sources of helium, and whose airship bases are unlikely to be attacked in force.

Airships may be divided into the small nonrigid, and large rigid types. The intermediate, semirigid type has never flourished outside of Italy and is probably obsolete.

The nonrigid airship, popularly called a "blimp," has a fabric envelope and is dependent upon internal gas or air pressure for maintenance of form. The rigid airship has a structural framework of girders and wires over which a fabric cover is drawn tight and smooth. This makes the ship independent of gas pressure for maintenance of form. In rigid airships the gas is contained within some dozen or more separate fabric cells analogous to watertight compartments of surface vessels, which are normally flabby from being only partially inflated. The use of inert helium for inflation makes the ship a much less vulnerable craft than it is popularly supposed to be.

American airship activity at present is confined to nonrigids. Seven of these airships, ranging in size from 120,000 to 400,000 cu. ft. volume are based at the Naval Air Station at Lakehurst, N. J. This is now our sole airship training and operating base, but Congress has approved the construction of two new airship operating bases upon our Atlantic coast, and the return to the Navy of the Airship Station at Sunnyvale, Calif., which was turned over to the Army in 1935.

Six patrol type nonrigid airships are under construction, and Congress has appropriated money for the construction of 21 more. These ships will have a maximum cruising range of about 2,000 nautical miles. They will be armed with depth bombs to drop on submerged submarines and machine guns to clear the crew from the deck of any submarine caught upon the surface.

Nonrigid airships on coastal patrol duty can stalk a submerged submarine at the sub's own speed and at a height of 100 to 200 feet above the water, which is the most favorable

position for stalking. The airship can also overhaul and examine closely or maintain contact with any surface vessel, friendly or otherwise. The contact may even be close enough for direct vocal conversation between the airship and the bridge of the surface vessel. The airship is also uniquely adapted to searching for mine fields.

These special qualifications of airships follow from their ability to fly as slow and low as may be desired, and they provide ample justification for including nonrigid airships in a well rounded program of national defense.

There are at present no rigid airships built, building or authorized for the U. S. Navy, but a long range program of Naval construction, as distinguished from an emergency one, might well include such craft as aerial airplane carriers. A large rigid airship of some 20,000,000 cu. ft. volume can carry a squadron of light bombing planes across the Atlantic or Pacific at twice the speed of a surface carrier. Moreover, airplanes based upon an airship instead of a surface ship can be launched more rapidly, and at an initial altitude of at least 2,000 feet. They can also be exceptionally efficient airplanes with high wing loading and without landing wheels.

Only American airships are inflated with helium, instead of the highly inflammable hydrogen, because America is the only country in which this wonder gas has been found in sufficiently large quantities to warrant its employment. After several years of brilliant performance, Germany's transatlantic airship service came to an end with the burning of the hydrogen-filled *Hindenburg* and the refusal of the United States to supply the greatly desired helium because of a suspicion, since justified, that Germany's intentions towards the rest of the world were not strictly honorable.

The present source of helium is a large natural gas field near Amarillo, Tex. The gas contains only about 1.8 per cent of helium, but with this small percentage as a basis, 97 per cent pure helium is obtained in the Bureau of Mines' extraction plant at Amarillo. The natural gas from which the helium has been removed is returned to the pipe lines and passed on to the consuming public as a slightly richer fuel gas than when it came from the ground.

Next to helium, the greatest American contribution to lighter-than-air has been the development of the modern mooring mast and mechanical ground handling. Airships are no longer held or handled on the ground by the strong arms and weight of large numbers of men. They are moored by their noses to masts about which they are free to swing horizontally. The ship is held down by ballast or other weight, and is supported by its taxi wheel, under the car of a nonrigid airship, or under the lower fin of a rigid ship. The taxi wheel moves along a prepared circular path as the ship swings around the mast.

There are two principal types of mooring mast, the fixed and the mobile. Fixed masts are quite simple affairs made of steel pipe, stayed laterally by steel cables fixed to anchorages in the ground and carrying at the top the cup into which the cone on the airship enters and is locked. The cup is free to rotate about the vertical axis of the mast, and the cone is free to rotate about the longitudinal and transverse horizontal axes of the airship.

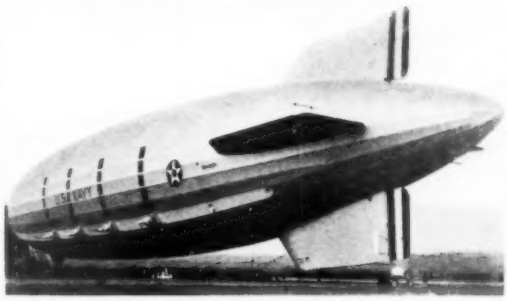
The mobile mooring mast carries the same mooring equipment as the fixed mast, but it is a pyramidal structure of steel angles and beams, supported on large pneumatic tired wheels at its three base corners and capable of being towed by a tractor. An airship riding to a mobile mast can be taken in or out of its hangar in all except extremely adverse weather conditions.

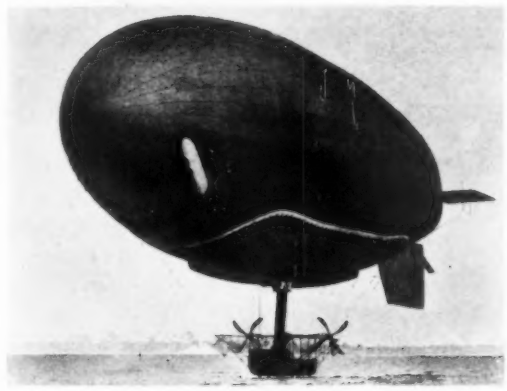
Personnel requirements for the lighter-than-air branch, during peacetime, are met by volunteers from the regular Navy, but since the Naval expansion program got underway there has been an acute shortage of personnel in all branches of the Naval service, and it has been necessary for lighter-than-air to seek its personnel from outside sources.

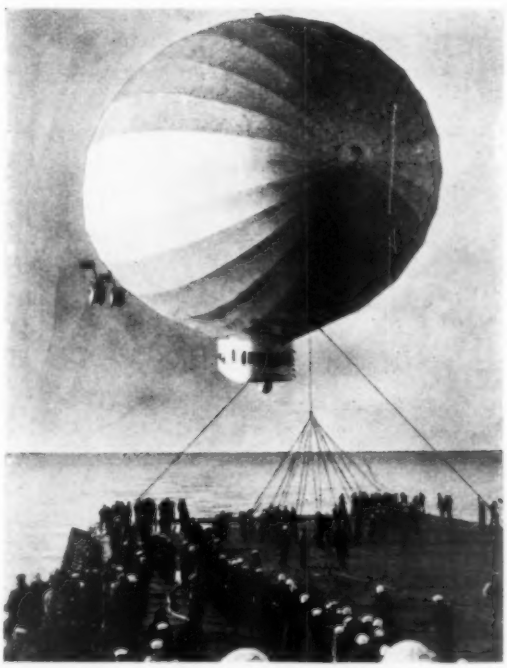
Officers for lighter-than-air are now obtained almost wholly by training and commissioning aviation cadets. The requirements for appointment in the Naval reserve as aviation cadet for lighter-than-air are identical with those for heavier-than-air candidates.

The selection of candidates from the many applicants is performed by the Naval Reserve Flight Selection Boards at the various Naval reserve bases scattered throughout the

NAVY AIRSHIP HISTORY

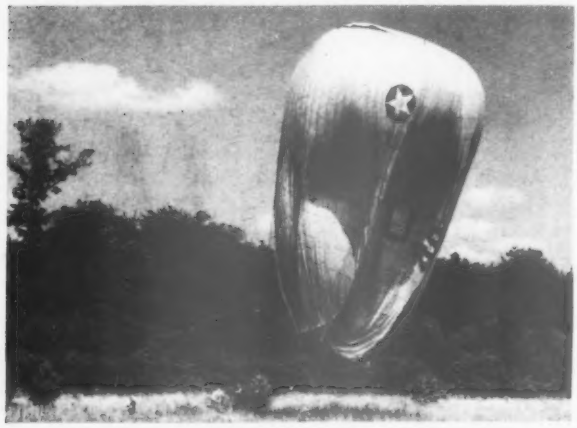




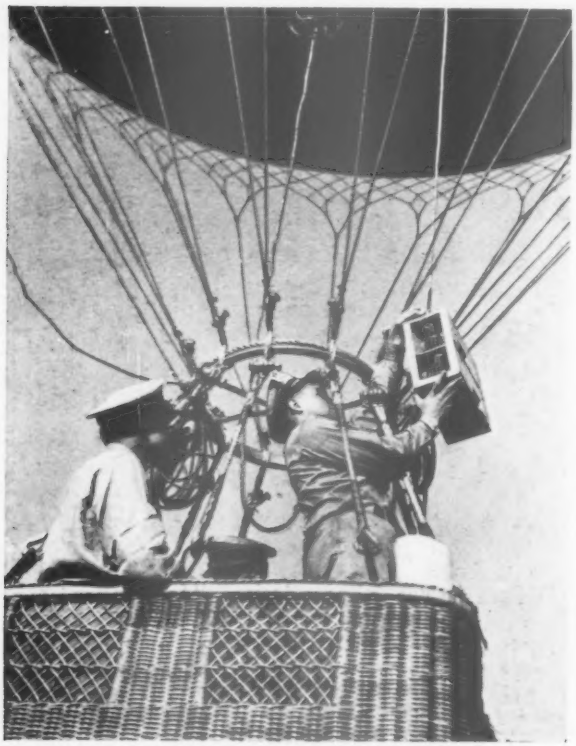


Costliest U. S. lighter-than-air experiment was building the ill-fated Akron and Macon (top). Both crashed, Akron with high loss of life. Blimp in the center is the Navy's first airship, the DN-1, built in 1917. Most successful rigid was the Los Angeles (directly above), recently retired as the world's last rigid dirigible. Navy now virtually has abandoned temporarily rigids for present highly successful types.

Round bags in center of Lakehurst's giant hangar are free balloons for training airship men. In background are the non-rigids.



Training balloon above is landing after cross-country flight. Basket (below) carries several men and cage of homing pigeons.



United States. Those selected are enlisted as seamen second class, V-5, U.S.N.R., for a 30-day preliminary training period, usually with a similar group in heavier-than-air. During this 30-day period both groups are given identical training. Those found to be best qualified are selected and appointed as aviation cadets. The aviation cadets desiring and desired for lighter-than-air training are transferred to the Naval Air Station, Lakehurst, N. J., for the full course for designation as Naval aviator (airship), and commissioning as ensign, A-V (N), U.S.N.R.

Enlisted candidates for the lighter-than-air school are selected from among those regular and reserve enlisted men who apply for the duty.

The events of World War II have proved the need, if war should come to our long coast lines and outlying island bases, for great numbers of Naval aircraft and surface vessels for patrol and submarine hunting. Many types of craft, including airships, have their special functions to perform in these activities. As a part of our great defense effort, a rapid expansion of lighter-than-air material and personnel has already begun; and there is every indication that this arm of the Navy will soon attain the important and flourishing position it deserves in the organization of national defense.

Editor's Note—The Navy purchased its first airship, a non-rigid, in 1915. Two years later 16 ships modified in design were delivered and used for training and coastal patrol, flying approximately 400,000 miles on this duty.

The third modification, known as the "C" type, was designed in 1918 and a contract for 30 was awarded. One craft of this group established a record of flying 1,022 nautical miles in 25 hrs., 50 min.

The "D," "E," and "F" types followed in rapid succession, each being a modification of the previous type.

The last of the Navy's non-rigid type, until the present expansion in lighter-than-air, were designated the "J" class. The new ships, 48 in number, will be designated the "K" and "L" types. Twenty-seven have been contracted for and three have been delivered.

Training for this program is being stepped up to keep pace with procurement. At present, there are 13 officers, approximately 100 aviation cadets and 235 enlisted men in training at the Naval Air Station, Lakehurst, N. J.

Concurrent with the training and procurement program must come expansion of shore facilities. Congress has appropriated $6,000,000 for the construction of a Naval air station with lighter-than-air facilities at Elizabeth City, N. C., and the same amount of money for a similar station at South Weymouth, Mass., both of which are scheduled for commission by May 1, 1942.

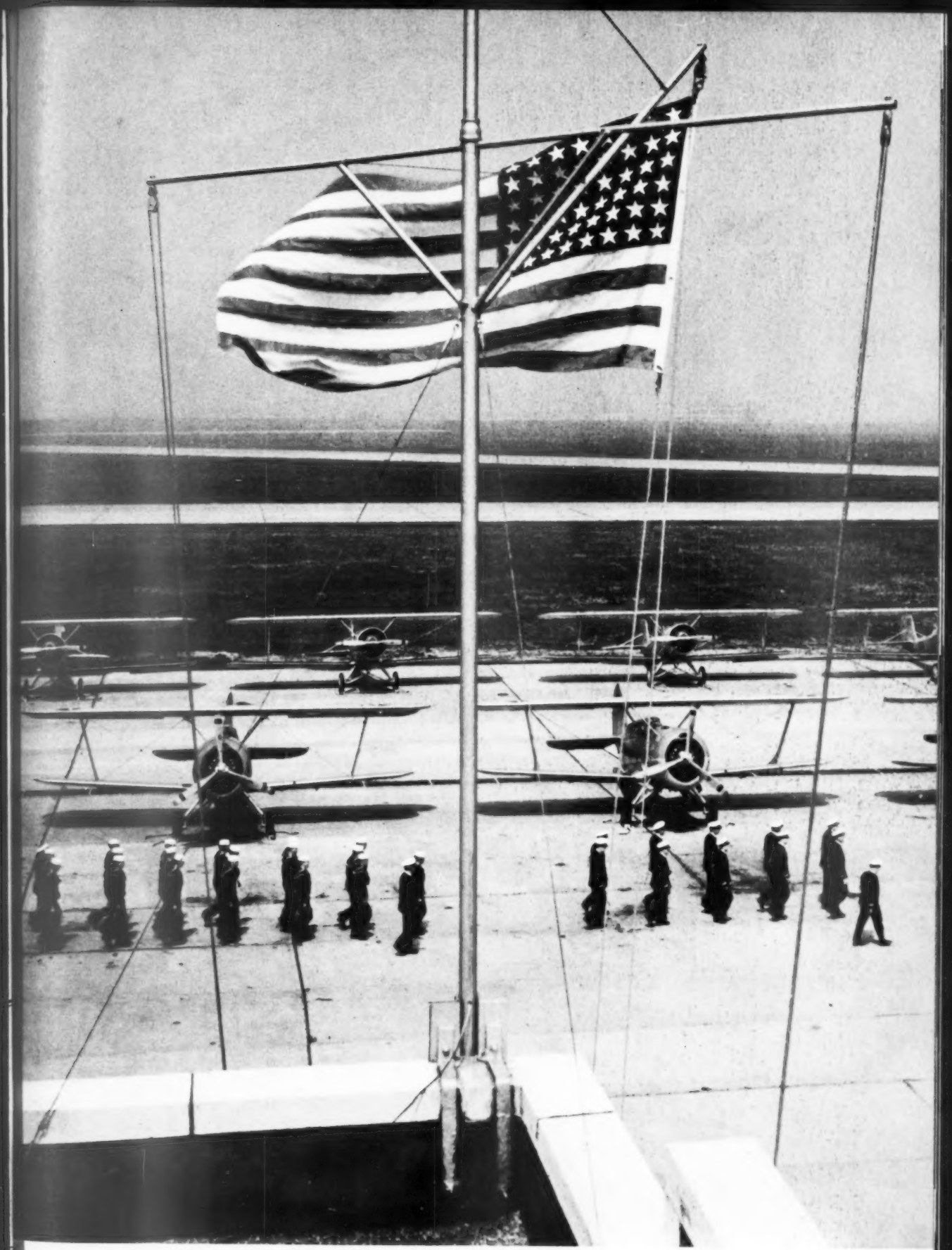
From the time the Navy's first blimp was delivered in 1915 to present day trim craft considerable progress has been made. Development of equipment and extension of utility and mobility have increased tremendously the value of these craft in Naval tactics. Mooring masts, for example, are now both mobile and easily transported from one point to another as the situation demands. Heavy take-offs up to 10 per cent of the airship's gross lift have been achieved. Wheel landings without the aid of a ground crew are now possible. From the standpoint of safety, carrying capacity, speed and utility these ships are expected to justify every objective of the new program.

END

AVIATION SALON

Thanks to its photogenic character, there is a fund of outstanding aviation pictures, taken by leading photographers. A selection of the best, devoted to U. S. Naval aviation, is presented on the 16 pages that follow.

For Salon Sidelights and technical data, see page 226



BEHIND THE FLAG

By Rudy Arnold

IN TRAINING

By Rudy Arnold

IN TRAINING

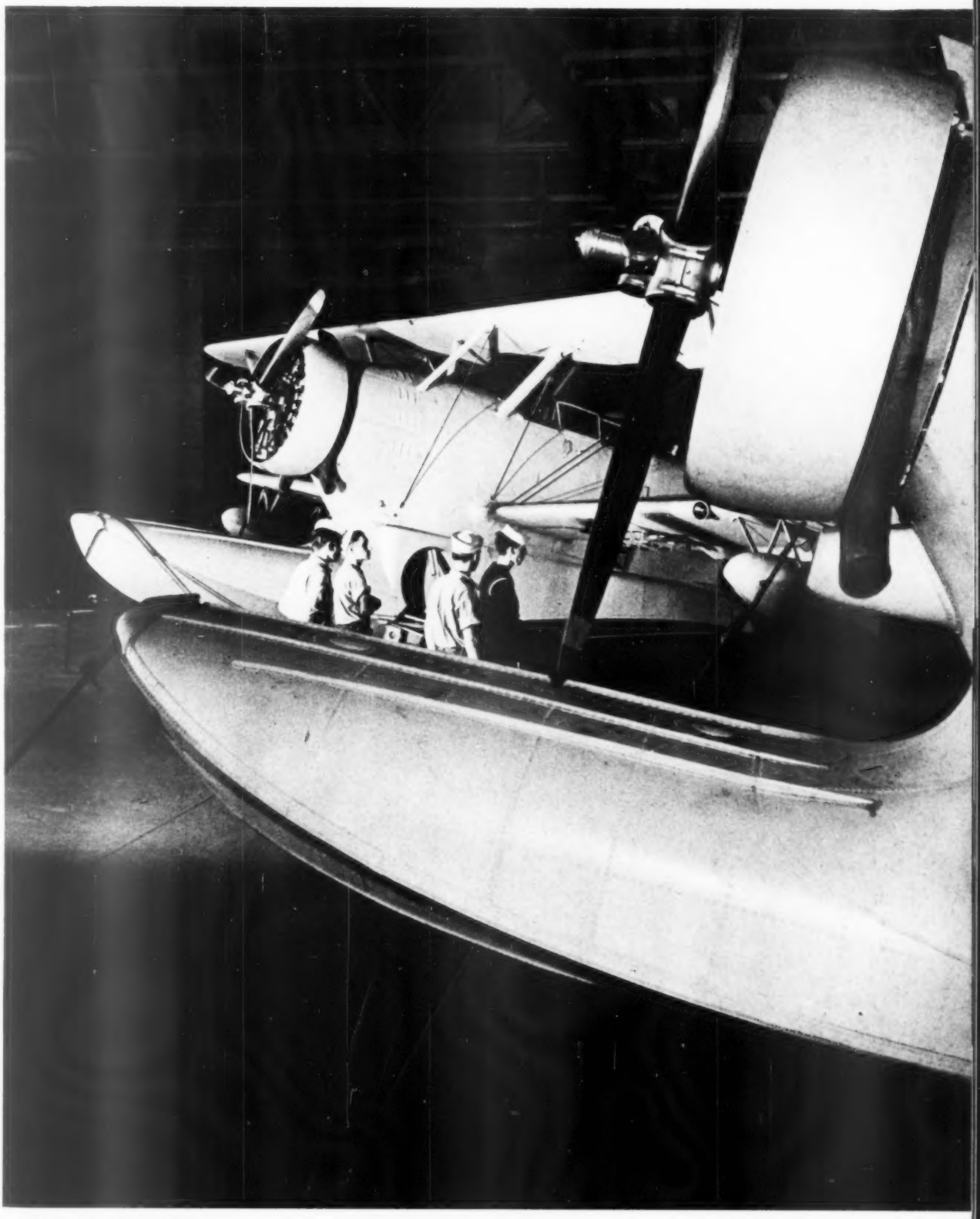
By Rudy Arnold

EYE OF THE FLEET

By Rudy Arnold

TOWER CONTROL

By Ulric Meisel

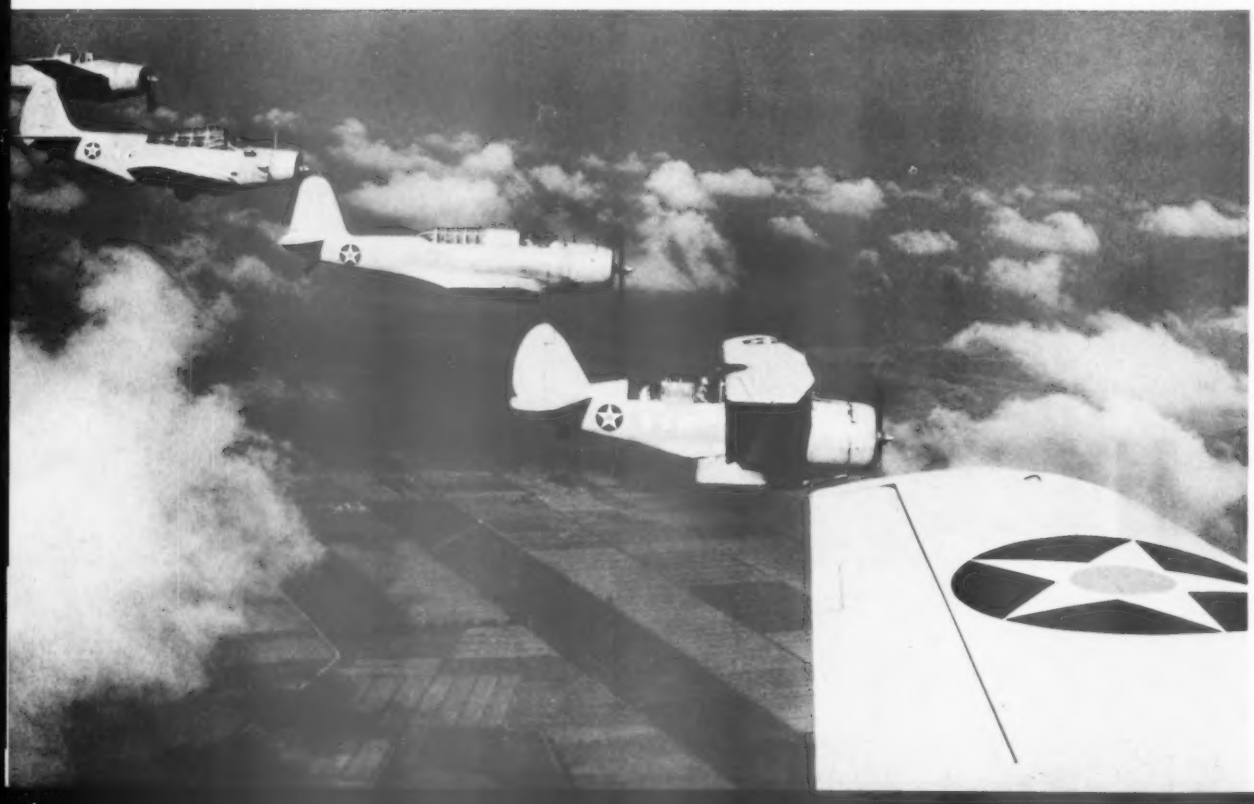


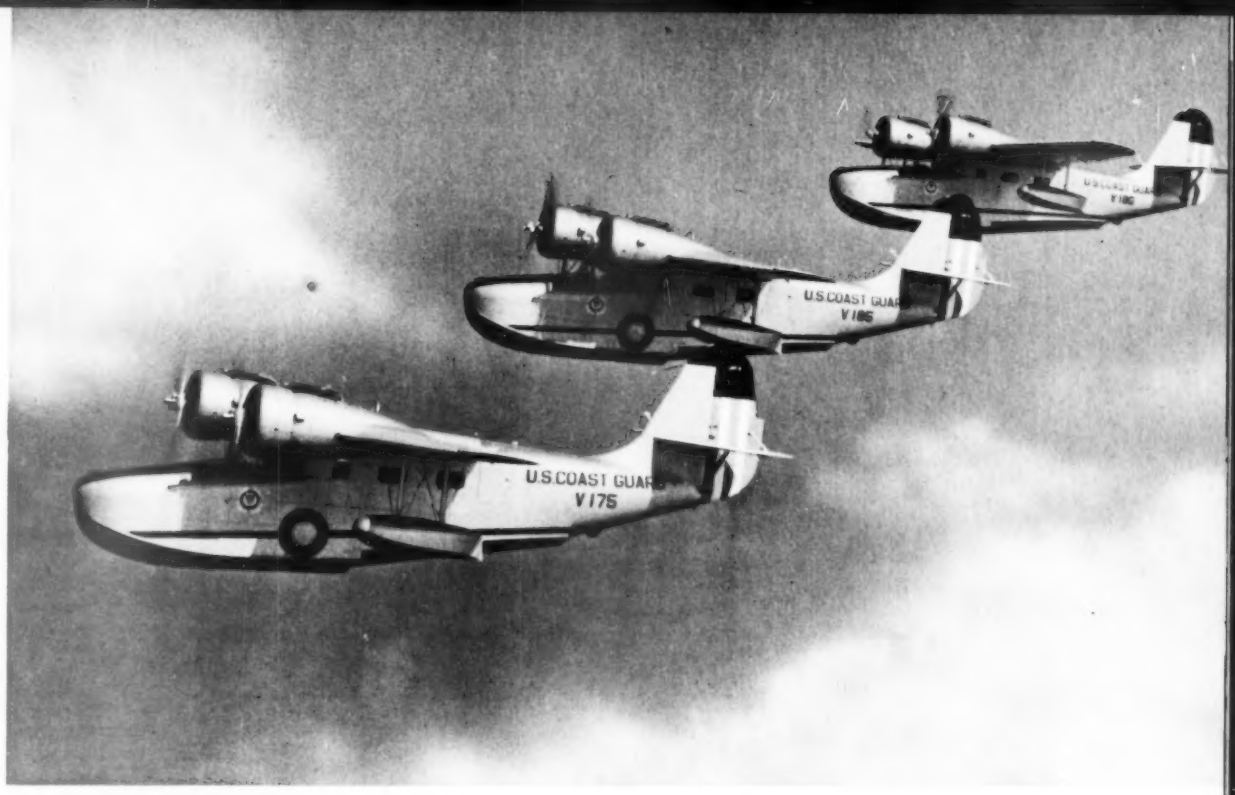
UNDER COVER

By Ulric Meisel

COURIER By Rudy Arnold

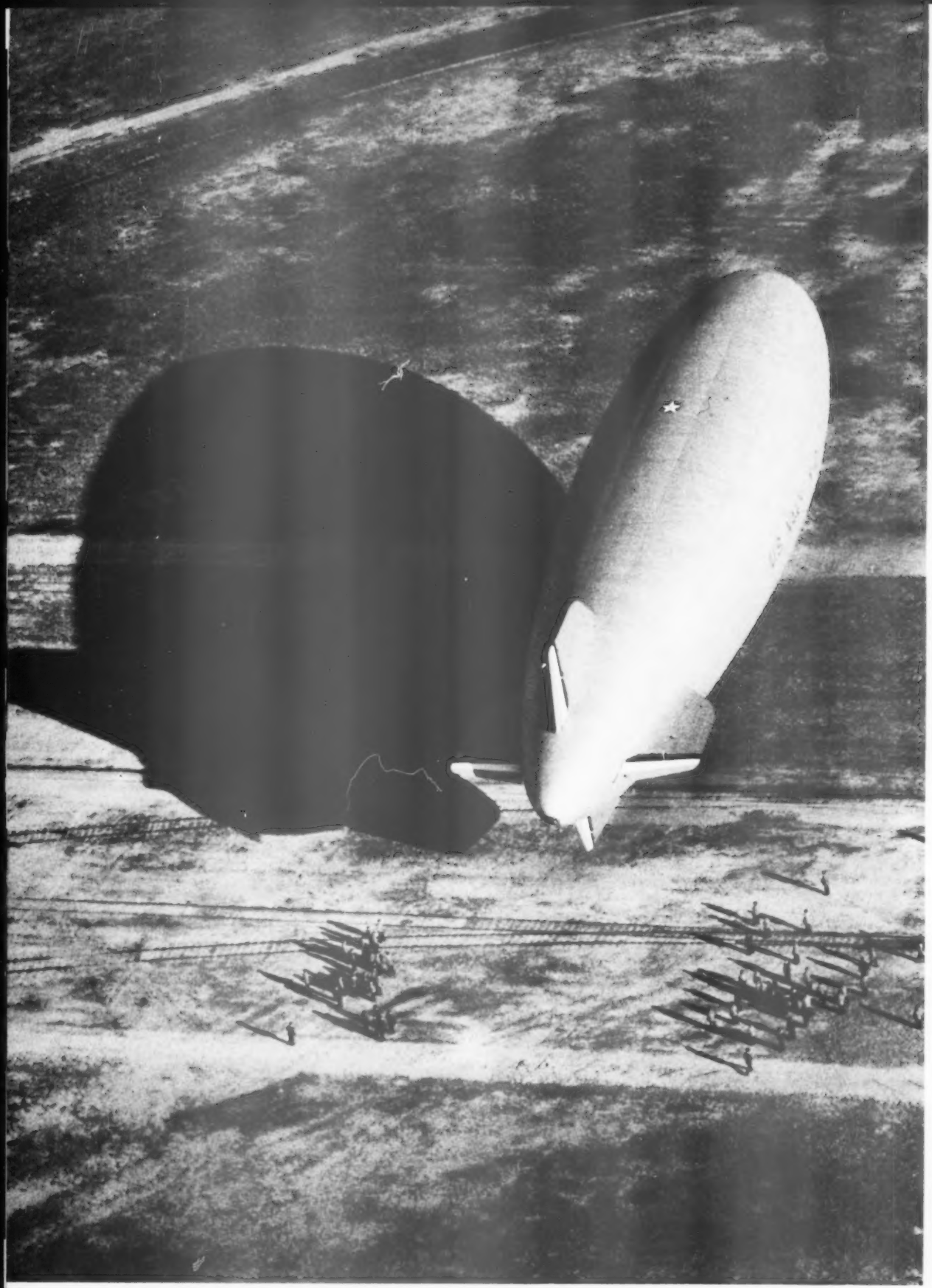
ON PARADE By Ulric Meisel





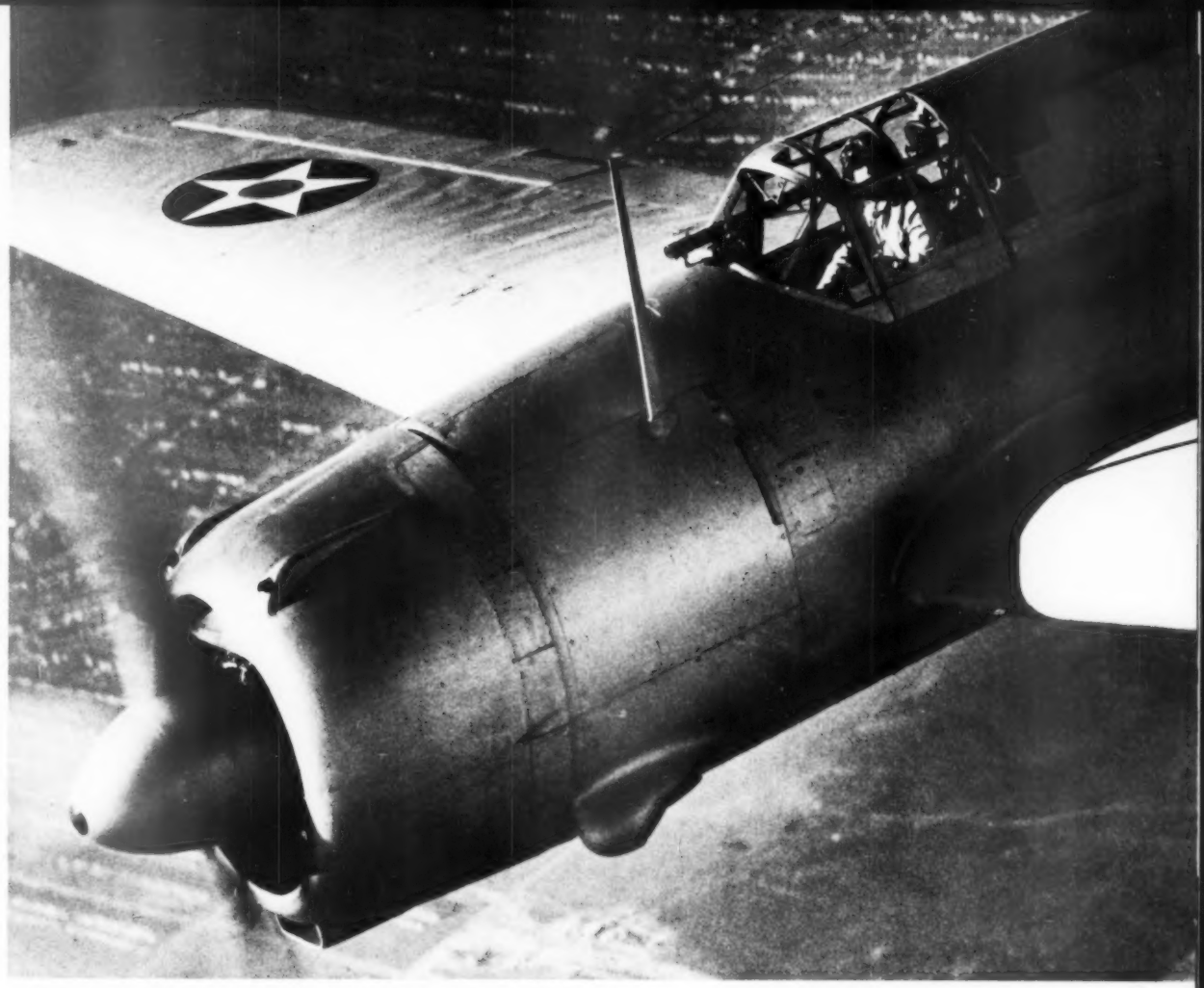
SEA PATROL By Rudy Arnold

AIRCRAFT WELDERS By Clyde H. Sunderland



BLIMP PATROL

By Rudy Arnold



CURTISS ''HELLDIVER'' By Rudy Arnold

BEACHED By Ulric Meisel

AERIAL DEFENDERS

By U. S. Navy

CONSOLIDATED "CORONADO"

By Otto Menge

BIRDS' NEST

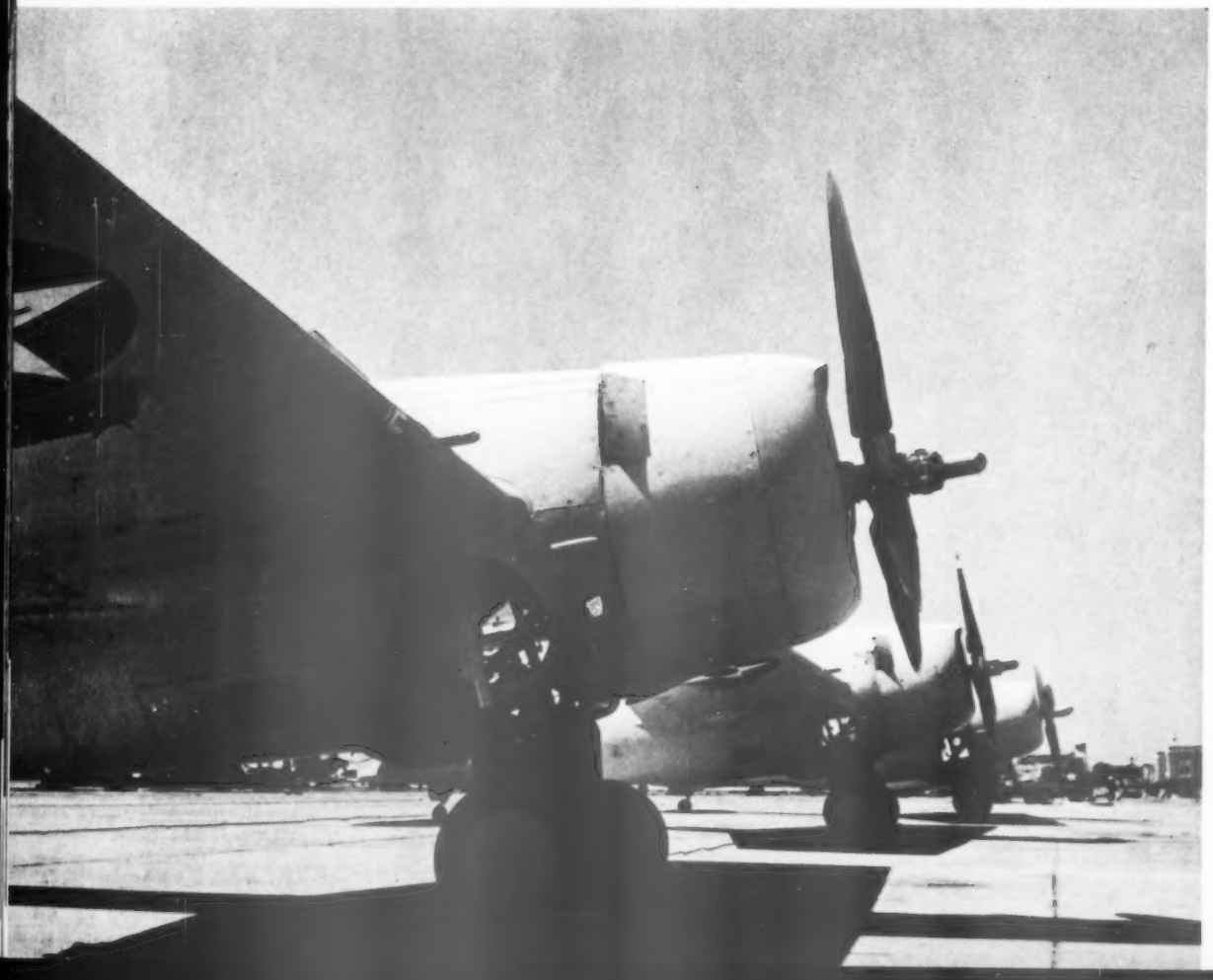
By Ulric Meisel

TRANSPORT
By Ulric Meisel

LEATHERNECK
By U. S. Navy

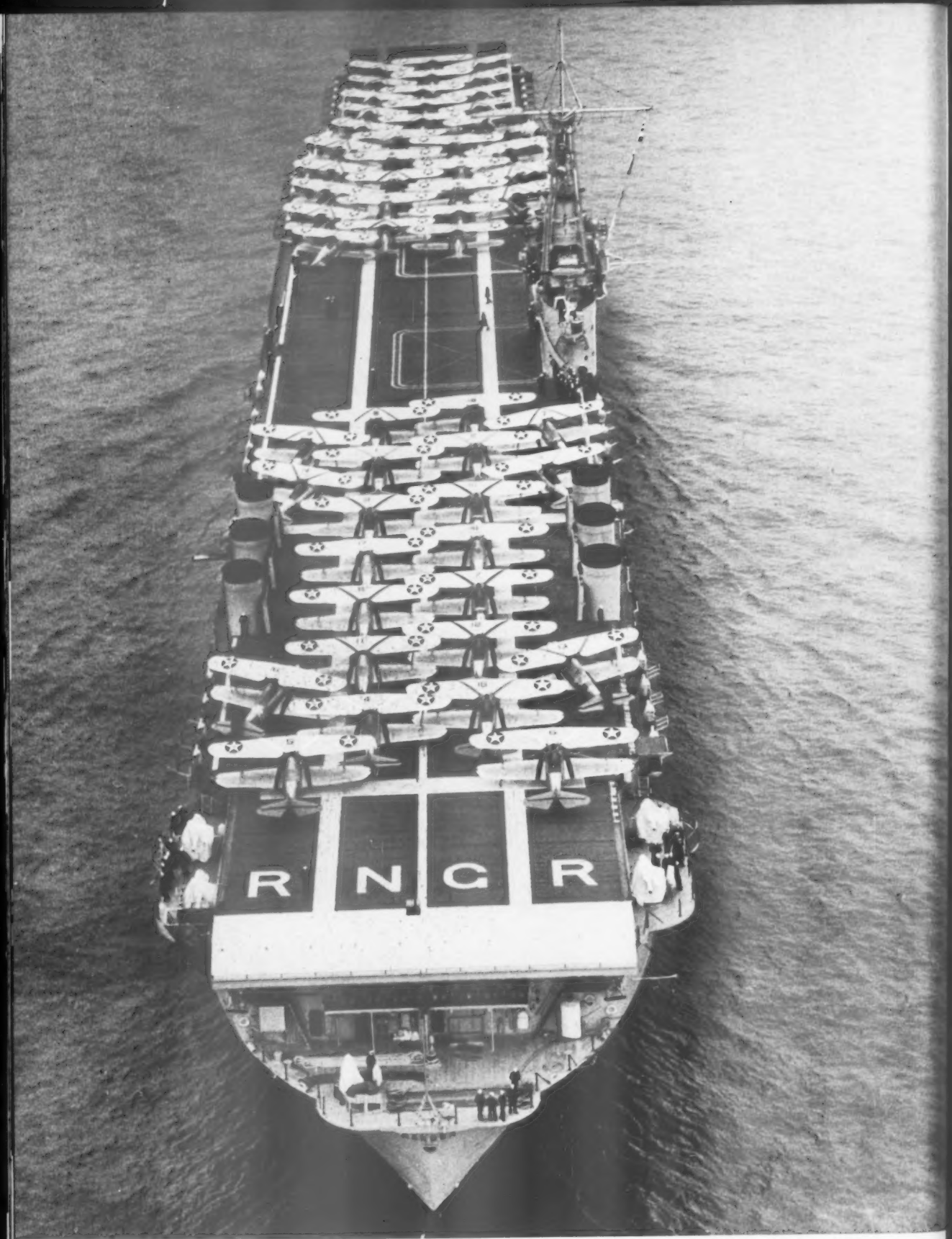
ON RECONNAISSANCE By U. S. Navy

GRUMMAN "WILDCATS" By Ulric Meisel



MARTIN
''MARINER''
By Ulric Meisel

ENGINE
SERVICE
By U. S. Navy



ROOST

By Rudy Arnold

CV —The CARRIER

Undeterred by heaviest weather, this fist of the Fleet air arm speeds through the night to carry the battle to the enemy and deliver swift, deadly blows early in the conflict.

by Vice Adm.
WILLIAM F. HALSEY

Holder of the coveted Navy Cross for convoy duty in World War I and already a veteran of various commands, Vice Admiral Halsey qualified as Naval Aviator in 1934, returned to Pensacola two years later as station commandant. Native of Elizabeth, N. J., he was graduated from the Naval Academy in 1904. Now, at 59, he is the commander of Carrier Division Two.

THE aircraft carriers are the mobile landing fields of the Fleet. No one who has followed the fighting in Europe and Africa during the past two years can fail to recognize the significance of this fact.

Today and from now on, wherever men fight, there will be found the airplane. The planes are the eyes of the admirals and generals who command the fleets and armies engaged; they augment and support the gunfire when the heavy surface forces come face to face. But long before the heavy units make physical contact, scouts and reconnaissance aircraft are maintaining a constant flow of information to their respective high commands on where the enemy forces are, how they are disposed and what they are doing. Coupled with this, the torpedo and bombing aircraft of the opposing forces initiate the actual exchange of blows while the main bodies are still hundreds of miles apart.

Thus it is evident that the airplane serves in the dual capacity of the far-seeing eye and the far-shooting gun; an eye that sees hundreds—even thousands—of miles, and a gun whose bullets, in the form of bombs and torpedoes, strike from at equally distant points. This concept of the field of aircraft in modern warfare tells in its broad outlines the entire history of their past and the balanced and true picture of their future. They exist for two purposes, and, even at this relatively early stage in their development, they have proved their superb ability to accomplish them; to get and report vital information and to strike swift blows early in the conflict.

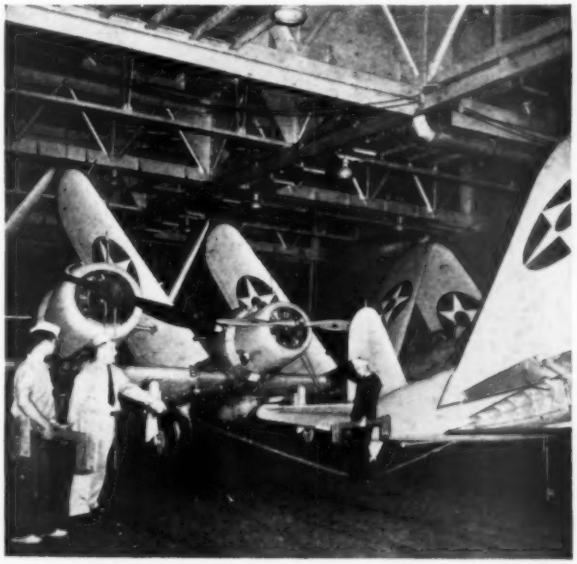
It is the latter of these two functions for which the carriers are primarily suited and employed. Long range patrol flying boats and cruiser-based scouting seaplanes must and do carry the brunt of the task of supplying information. The carriers with their balanced groups of striking aircraft are the fist at the extremity of the Fleet's air arm.

These huge, swift ships, capable of great speed and sea-keeping qualities in the heaviest weather, stab deep into the no man's land toward the enemy with full loads of the heaviest bombs and torpedoes. They strike swiftly—and repeatedly if need be—carrying out the age-old rule "The first blow is half the battle." The most sluggish imagination must stir to the picture of these splendid ships steaming silently and completely darkened at express train speed throughout the night, to rain trip-hammer blows again and again on enemy ships or coasts a half thousand miles or more from their starting point of the night before. This is the destiny of our carriers.

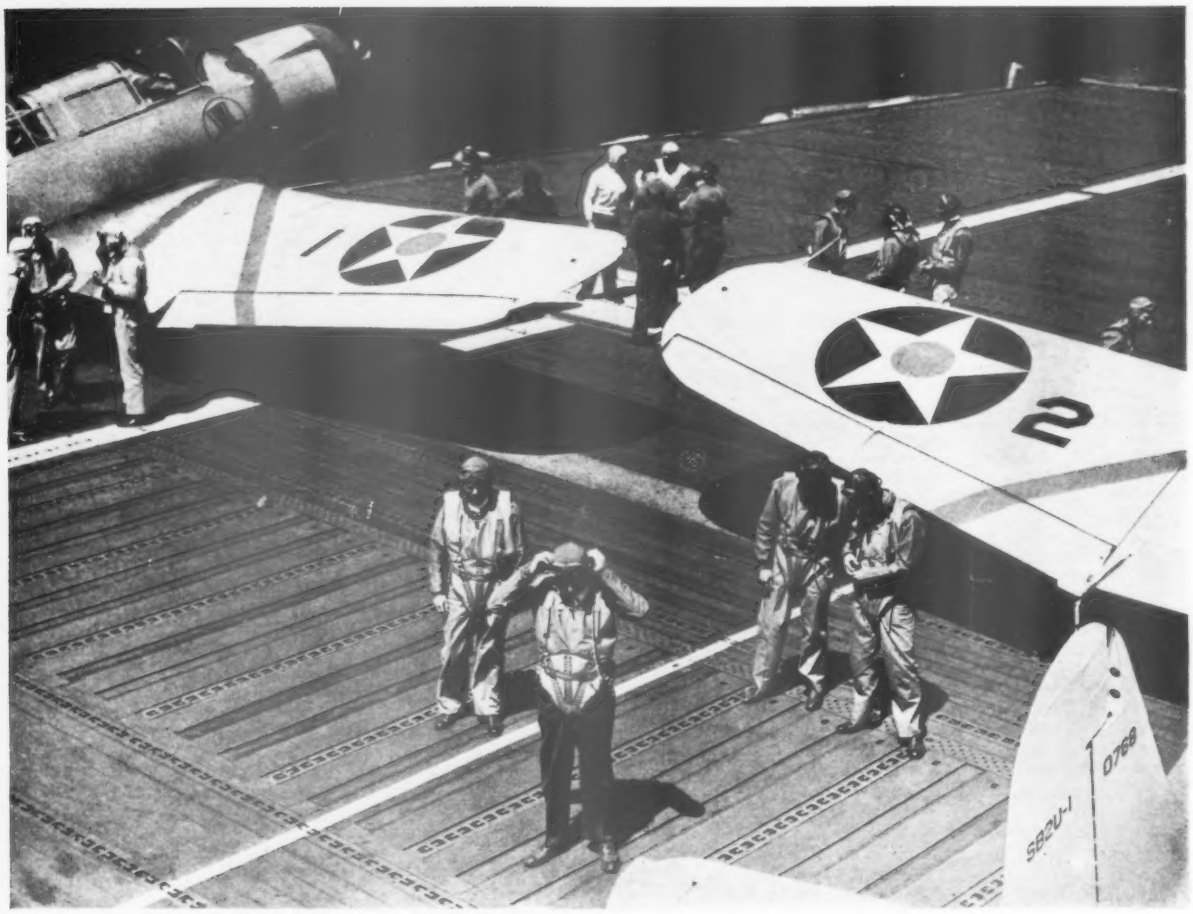
The first operation of a landplane on a Navy ship occurred in 1910, when Eugene Ely took-off a plane from a temporary deck erected on the forward part of the *U.S.S. Birmingham*. The following year this same pilot made the first carrier landing on a deck erected on the after part of the *U.S.S. Pennsylvania*.

This deck was only 120 feet long and 32 feet wide, and the only thing separating the forward end of the deck from the ship's mast was a piece of canvas placed vertically at the end of the platform. Lines stretched athwartship the deck, weighted at each end by sand bags, were spaced throughout the length of the deck and lifted away from the deck in order that they might engage hooks installed on the plane. The plan, as conceived, involved the plane passing over the deck close enough to allow the hooks to engage lines. The pull of the plane on the lines would be resisted by the weight of the sand bags, which, as additional lines were engaged, provided an increasing force to arrest the forward speed of the aircraft. On this original landing the platform was stationary (the ship was at anchor) and the wind was blowing across the deck, presenting a most difficult situation. However, because of the pilot's great skill, the landing was successful.

The operation was received with great enthusiasm and the



These "Vindicator" scout bombers, like all large carrier-based planes, have folding wings to facilitate storage below decks.



Painted lines on carrier deck guide pilots in landings and take-offs. Rows of perforations are plane tie-down hooks.

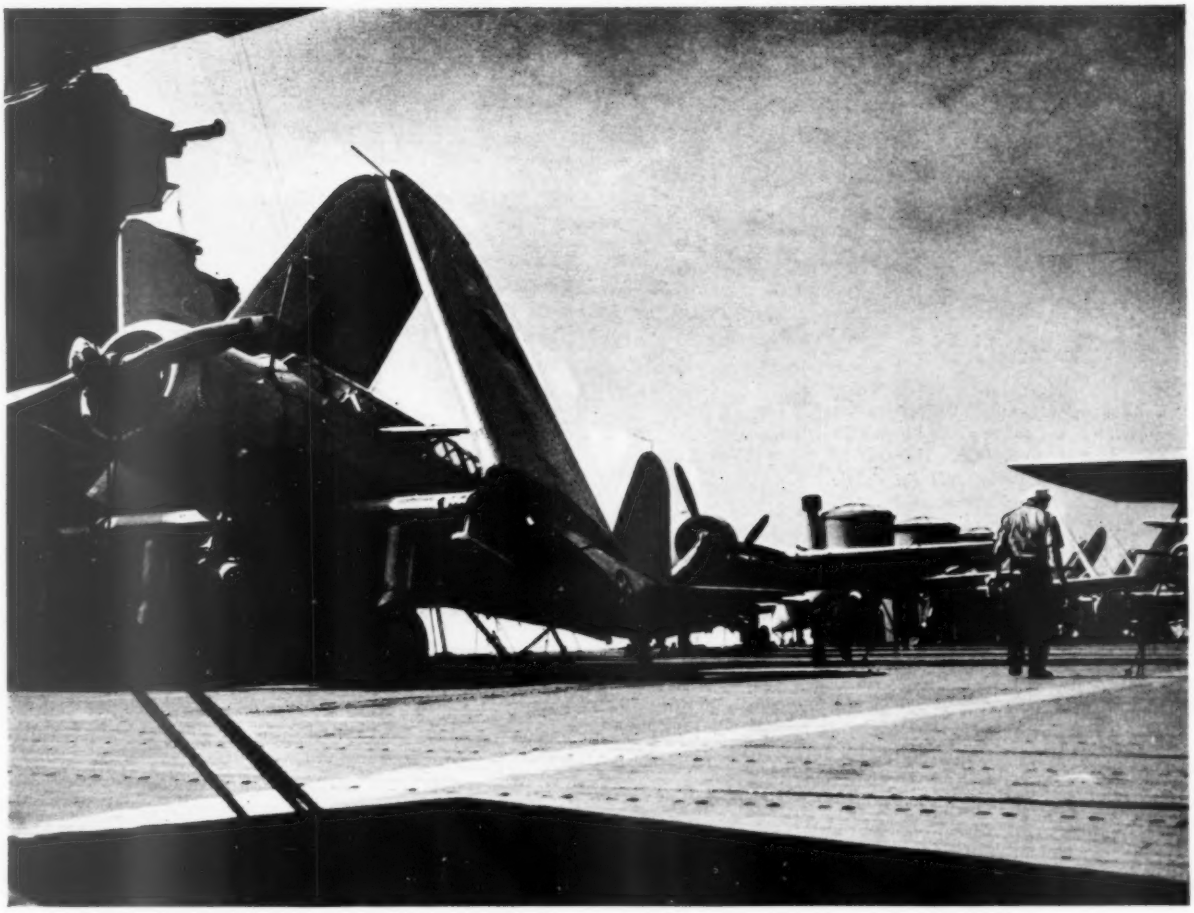
Pilots and flight personnel always keep pot boiling for traditional "coffee mess" during operations. The inviolable rule demands that hot drink be available at all hours.

possibility of landplane operations from surface craft in the future was visualized by many who witnessed it. It was also immediately apparent to a very small group that the operation would have been greatly simplified had the ship been underway, steaming directly into the wind.

Thus the first aircraft carrier operations were carried out. Almost as spectacularly, the operations were somehow forgotten and no further interest in such operations was shown by our country until after the World War. During the war the British had, of necessity, experimented with various means of utilizing high performing landplanes at sea and, as a result of many trials, finally completed a ship for use as an aircraft carrier in 1918.

In 1919 the United States Navy regained interest in the subject and, as a result, a collier was converted into a flush deck carrier. This was the *Langley*, commissioned in 1922. (It is interesting to note that this original carrier is the only carrier we have built or contemplate building which has all structures below the flight deck.) The *Langley*, during the middle '20's pioneered actual fly-on and fly-off technique, the accomplishment of which, at first, was only possible by a select group of pilots. However, other pilots demanded their opportunity to operate on the carrier. They were soon given this opportunity, the results of which proved the ability of the average Naval aviator. Many mishaps occurred during these early operations; many lessons were learned. The pioneers of carrier aviation were definitely an aggressive and enthusiastic lot, and their efforts, experiments and mishaps were not in vain because from them has been developed a technique that provides smooth, rapid operations with a minimum of operating difficulties.

Today, it is a fact that the pioneer would cheerfully doff his



Scout bombers (wings folded) and fighters are tied to sunken hooks when stored on flight deck.

hat to the younger boys who are operating complicated aircraft from the carrier, day and night, on wide-spread missions unthought of in the early days of Naval aviation.

In 1928 the *Lexington* and *Saratoga* were commissioned as aircraft carriers. Both these vessels were originally intended as battle cruisers, so their design as carriers, except for their flight deck, was not ideal. Modifications and possible alterations have been introduced from time to time, so that today, after 13 years of sustained operations, these powerful, seasoned vessels present a consistent flexibility and co-ordination of air group operations that have never been excelled.

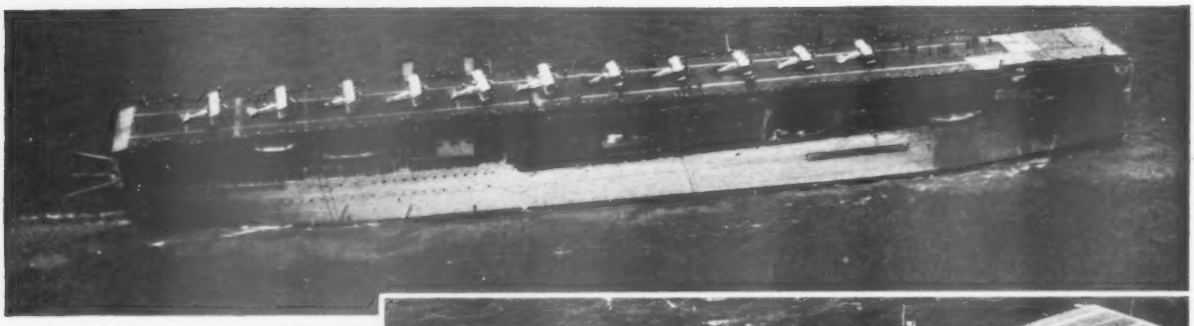
In 1934 the *Ranger* was commissioned. She was our first ship originally designed as an aircraft carrier. About the time of her commissioning the *Langley* was converted to a seaplane tender, and the air group was shifted to the *Ranger*. The *Ranger* joined the two large carriers and these three have operated equally efficiently with the battle Fleet for many years.

From much data gathered through the adolescent years of carrier operation and the hard knocks of experience, the Navy designed its present type carriers. The *Yorktown* and *Enterprise*, commissioned in 1937, incorporated all known improvements in operating facilities and design at the time they were built. These ships operated on the east coast until the end of 1938 and then joined the U. S. Fleet.

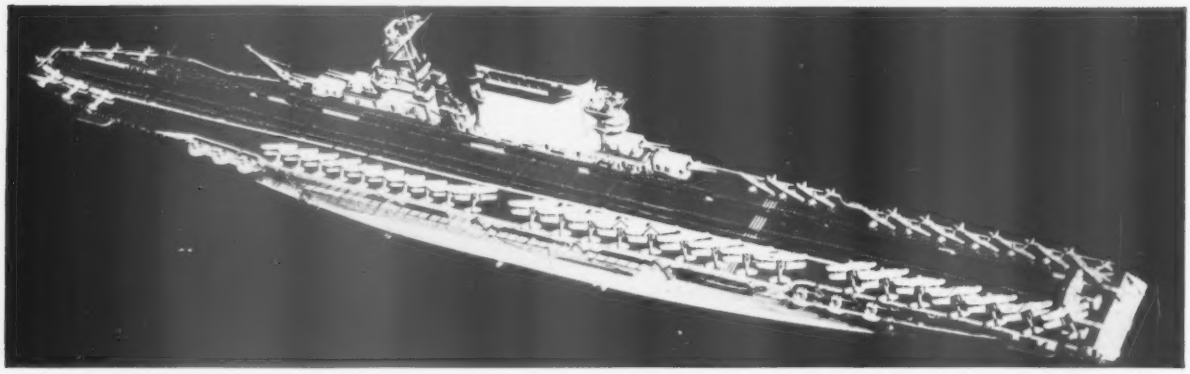
This cruise provided the Fleet carriers with greater sustained training and operations than any previous training cruise. On the return of the Fleet to the Pacific the *Ranger* remained on the east coast. The *Wasp* and *Hornet*, very similar in design to the *Yorktown* and *Enterprise*, have already been commissioned and are now operating.

The Navy Expansion Program included the building of a

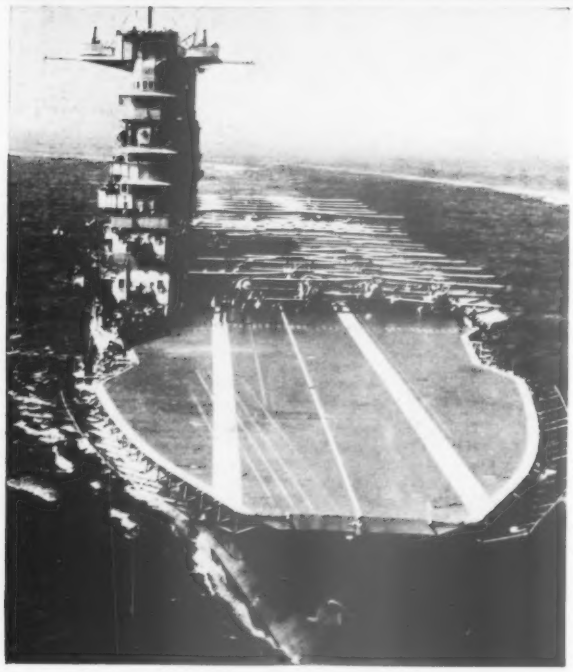
Present during all carrier operations is "Asbestos Joe." Volunteering from the ranks and equipped to meet any fire hazard, he is an integral part of the "ground crew" of every Navy carrier.



U.S.S. Langley (above), the Navy's first carrier, was the collier Jupiter before its conversion in April, 1920. The Langley now is seaplane tender AV3 (at right), following its second conversion in 1937. The Navy's first electrically-propelled vessel, its designed speed was 15 knots.



More in line with aircraft operations was the U.S.S. Lexington (CV2). Primarily a cruiser, its maximum speed is 33.9 knots.



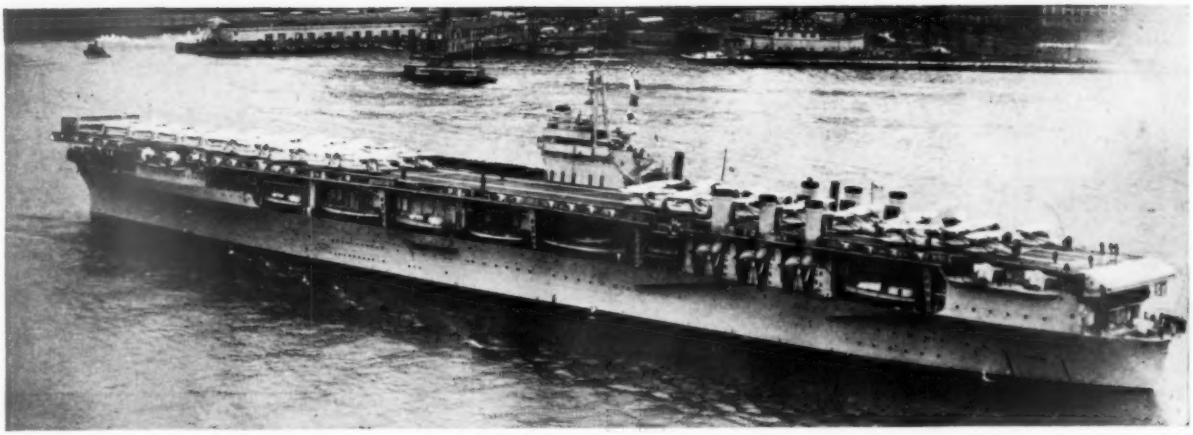
Photograph at left, from a plane taking off, shows the U.S.S. Saratoga running full speed. "Sara" is a converted cruiser.

total of 18 aircraft carriers for our Navy, seven of which are now commissioned and two under construction. The selected names of future carriers, in order of their construction, are: *Essex, Bon Homme Richard, Intrepid, Kearsarge, Franklin, Hancock, Randolph, Cabot, Bunker Hill, Oriskany,* and *Ticonderoga.*

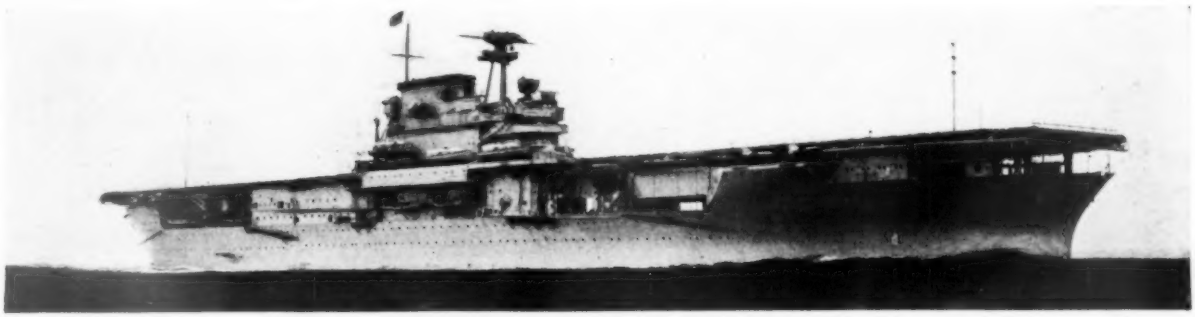
The design of our carriers has necessarily been a compromise in order that many important, yet conflicting, factors may be given proper consideration. Varying missions of aircraft; difference in their size and performance; necessary ship's armament and speed; the number of planes operating; necessary aviation facilities—all definitely affect design. Thus, like many other Navy ships, though more complex than most, carriers must be constructed to allow the greatest possible degree of flexibility in operation and maintenance of aircraft.

An important feature of a carrier, in addition to its flight deck, is the hangar deck. Planes are moved between these decks by means of large power driven elevators. The hangar deck affords the best location for planes undergoing repair. To facilitate repair and overhaul, all shops, storerooms, offices and lifting gear are located on or near this deck.

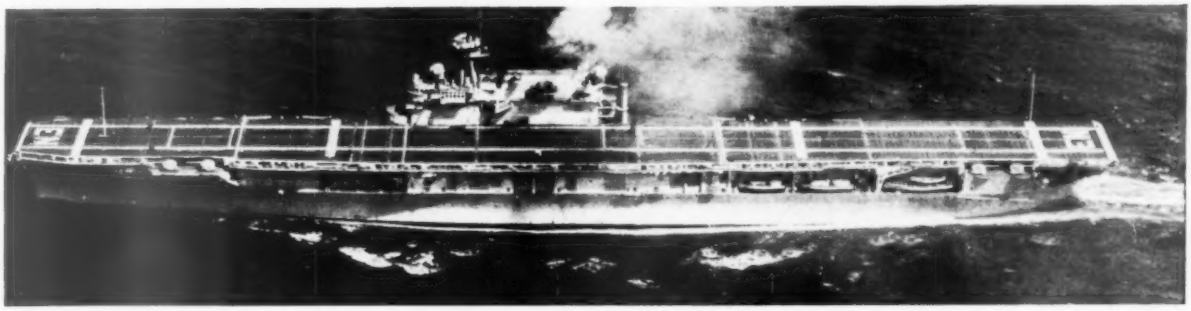
Carriers contain all departments found in other Naval vessels, namely: gunnery, engineering, navigation, construction and repair, medical and supply, and, in addition, the important



First real aircraft carrier was U.S.S. Ranger (CV4) above. It is lighter and slower than CV3.

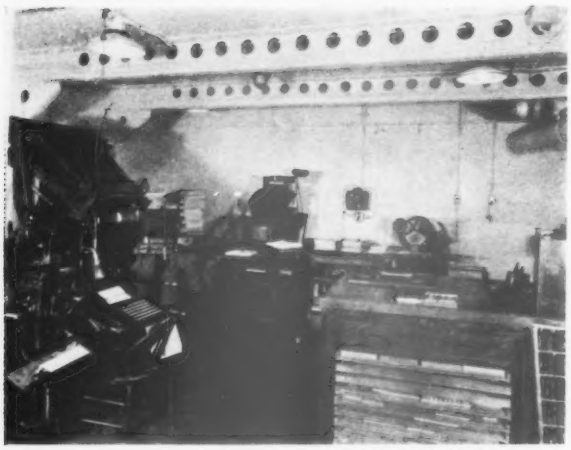


Designed displacement of CV5, U.S.S. Yorktown (above) is 19,900 tons. Other data restricted.

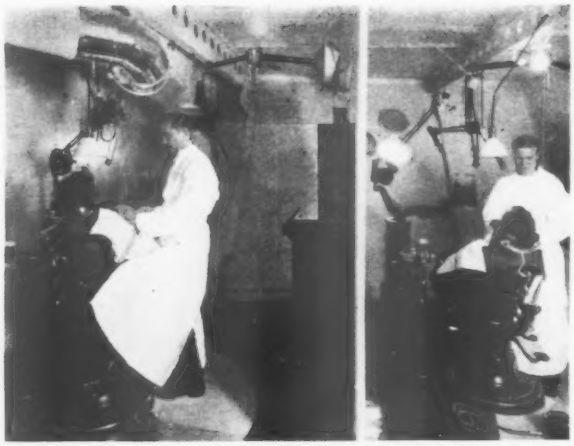


U.S.S. Enterprise (CV6) is sister of Yorktown. Letters EN on deck identify vessel. Lexington is LEX, Ranger is RNGR.

Sixth Naval vessel to be named U.S.S. Wasp, CV7 (below), was authorized in 1934 and commissioned in April, 1940.

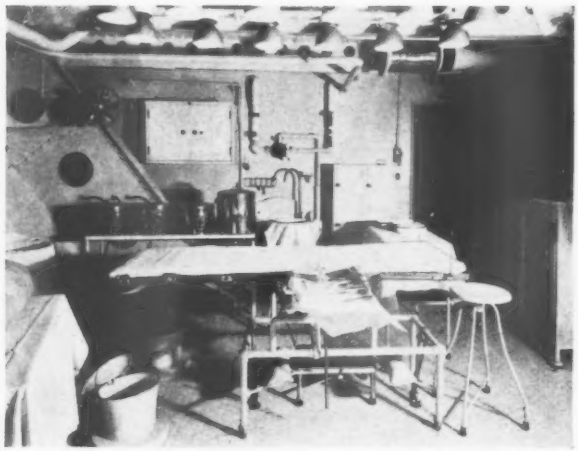


An elaborate printing plant is standard equipment on carriers.



U.S.S. Lexington, like all carriers, offers full dental service.

Carrier personnel have access to complete barber facilities.



This modern operating room is part of carrier's medical service.

air department. This department's personnel consists of the air officer and assisting officers, all of whom are Naval aviators, and necessary ratings and seamen. It is interesting to note that on all carriers of our Navy the commanding officer, the executive officer and the navigator are all Naval aviators.

The air department is responsible for the administration and control of all aviation activities. Squadrons, when embarked, retain their identity but become a part of the air department and, as such, operate as an integral part of the ship. The air department provides: all necessary facilities for operation, maintenance and upkeep of aircraft; the storage and maintenance of all aviation accessories; work shops, berthing facilities for personnel, etc. Squadron personnel in non-flying status are utilized as necessary in forming the air department organization. Many details are required in this organization, including such jobs as plane handling crews, ordnance men, fire crews, plane directors, inspectors and fuel squads. Officers of the air department perform such duties as control of aircraft on or about the carrier, overhaul and repair, intelligence, servicing and gunnery.

All pilots and air department personnel are thoroughly drilled in their duties through constant instruction and sustained operations. Each carrier continually attempts to improve technique and smoothness of operations, and when new ideas arise they are passed on to other carriers for consideration. Competition among carriers is keen yet friendly.

Like the old general who advocated "Gittin' thar fustest with the mostest men" as the best means of coming out ahead, those responsible for carrier operations strive incessantly to operate the maximum number of planes in the minimum space of time. Safety precautions, however, instead of being ignored, are rigidly adhered to. Damage or injury through carelessness is practically unknown. When it is considered that between 70 and 80 airplanes are operated in a space which averages approximately 750 x 83 feet overall, the necessity for a high degree of co-operation, skill and dexterity can readily be appreciated.

Let us briefly consider a single operation: The necessary contingent of planes are embarked on the carrier, and the huge floating base steams out to sea for the contemplated scene of operations. When this point is reached, the ship's bugle sounds flight quarters. The massive ship springs into action. Pilots report to their "ready" room, air department personnel man their stations. The navigator at his post takes a swift reading, determines the heading and necessary speed. The engineer orders necessary power. The plane crews warm up the engines as directed. The air department relays information on immediate operations to the "ready" rooms. The command that cocks the trigger of the Navy's biggest weapon is given —"Pilots, man your planes."

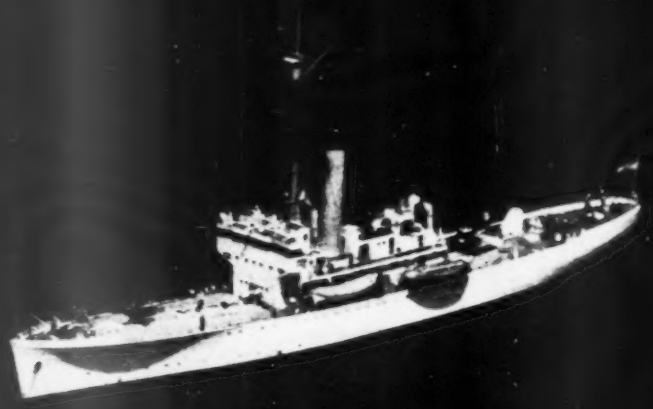
Pilots report to their planes and give last minute checks before launching. The captain, assured all planes are ready, gives the order. One by one with exact precision they roar down the deck and into the air, circling to gain formation. The squadron leader clicks his interplane phone, and the pack blasts its way through the air toward the destination.

Air discipline is maintained at all times. Without this, air-

(*Continued on page* 164)

A Coast Guard Grumman JRF-1 over the U.S.S. Pontchartrain.

THE COAST GUARD



The aerial watchdogs of American shores, Coast Guard flyers now are carrying on as part of the Navy's aviation arm.

THE COAST GUARD

by Rear Adm. RUSSELL R. WAESCHE

Credited with having originated many measures to increase the efficiency of the U. S. Coast Guard, and now serving his second term as its commandant, Rear Admiral Waesche has spent the past 37 years in Coast Guard service. Prior to his appointment to the Coast Guard Academy May 19, 1904, he attended Purdue University. Born at Thurmont, Md., January 6, 1886.

UNTIL comparatively recent years the majority of people did not realize that the U. S. Coast Guard had its own aviation branch. It is true that this service, operating in peacetime as a part of the Treasury Department and in time of war as part of the Navy, is small when compared to its sister services. However, its effectiveness and great efficiency earns the old fashioned phrase of "dynamite comes in small packages."

Law enforcement at sea has long been synonymous with the name Coast Guard and its history of 150 years includes fighting with the Navy in practically every war in which the United States has engaged.

On August 4, 1790, President George Washington approved a Congressional Act creating the Revenue Marine, the ancestor of the present service. Its first military engagement was against the French in 1798. The War of 1812 saw Coast Guard cutters in prominent engagements. The Seminole uprisings in 1836, the wars with Mexico and Spain and the World War found the Coast Guard actively engaged.

Aviation came to the Coast Guard through the passage of the Naval Appropriation Act, approved August 29, 1916, authorizing the Coast Guard to establish, equip and maintain air stations, not to exceed 10 in number, on the Atlantic and Pacific coasts, the Gulf of Mexico and the Great Lakes.

Before action could be taken to acquire land for the first air station, however, the United States entered the World War and the Coast Guard, for the duration, became an integral part of the Navy.

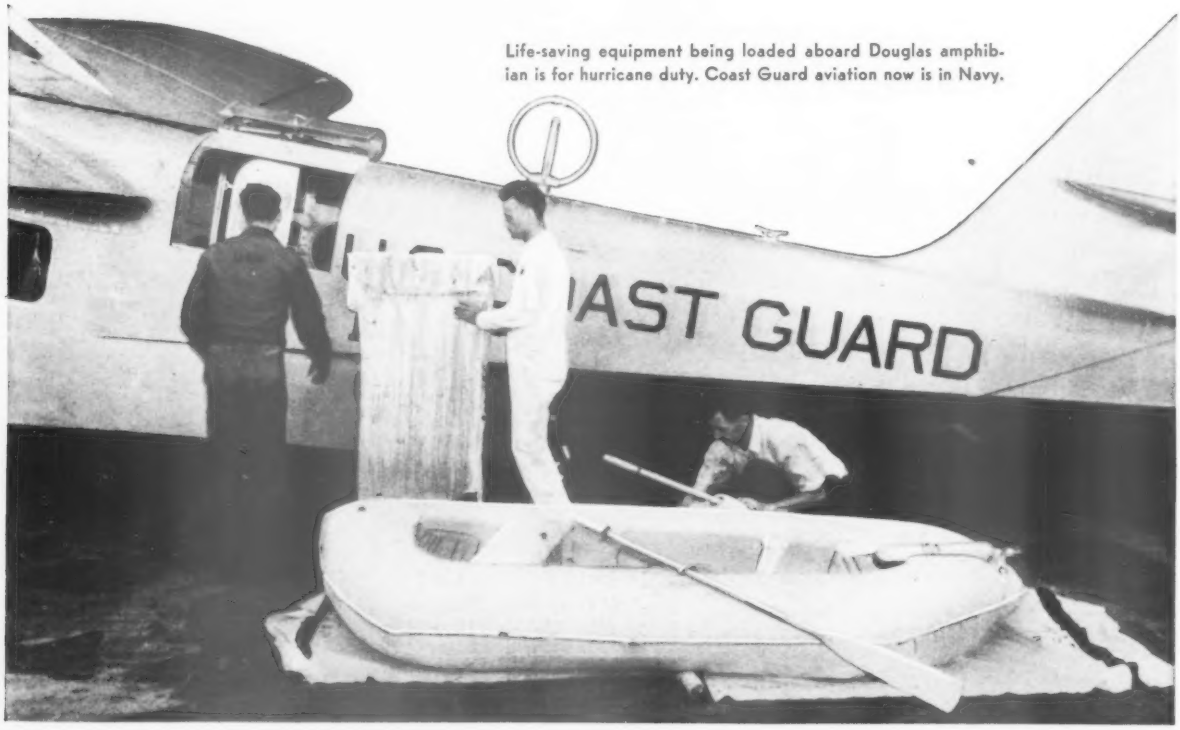
During this period a group of Coast Guard officers and enlisted personnel were sent to the Naval Air Station, Pensacola, Fla., for indoctrination and flight training. Upon completion of the course they were detached to various Naval air stations in this country and in France. One Coast Guard officer, assigned to the Naval Air Station, Ile Tudy, France, later became its commanding officer and received from the French government the rank of Chevalier of the Legion of Honor.

Shortly after the Armistice was signed, the Coast Guard was returned to the jurisdiction of the Treasury Department, but it was not until the spring of 1920 that the Naval air station at Morehead City, N. C., with six HS-2 seaplanes, was made available.

It was thought with this beginning that aviation in the Coast Guard would progress rapidly. However, the Morehead City air station remained in operation only about a year before it was discontinued for lack of funds. The personnel returned to duty at shore stations and boats and the planes were returned to the Navy.

For a few years thereafter, despite the epochal transatlantic flight of the Navy NC-4 to England, on which a Coast Guard officer was one of the pilots, and the fact that military services were becoming more and more interested in the design and production of the airplane, it seemed that aviation in the Coast Guard was still in the dream stage, a long way from reality.

Luckily, there were some air-minded officers in the Coast Guard who had sufficient breadth of vision to realize that airplanes would be of material assistance in furthering and efficiently executing the varied duties of the service. It was largely through their efforts that, in 1925, a $152,000 appropriation was granted by Congress for the purchase of five seaplanes and equipment.



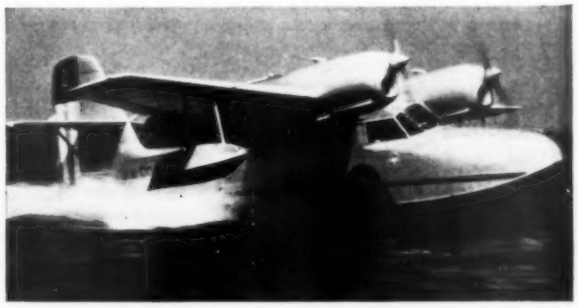
Life-saving equipment being loaded aboard Douglas amphibian is for hurricane duty. Coast Guard aviation now is in Navy.

Grumman JRF-2 is standard twin-engined amphibian now used by Coast Guard for patrol and rescue work.

A Coast Guard favorite was Douglas RD-4, popularly known as the "Dolphin." Bigger, faster amphibians replace these.

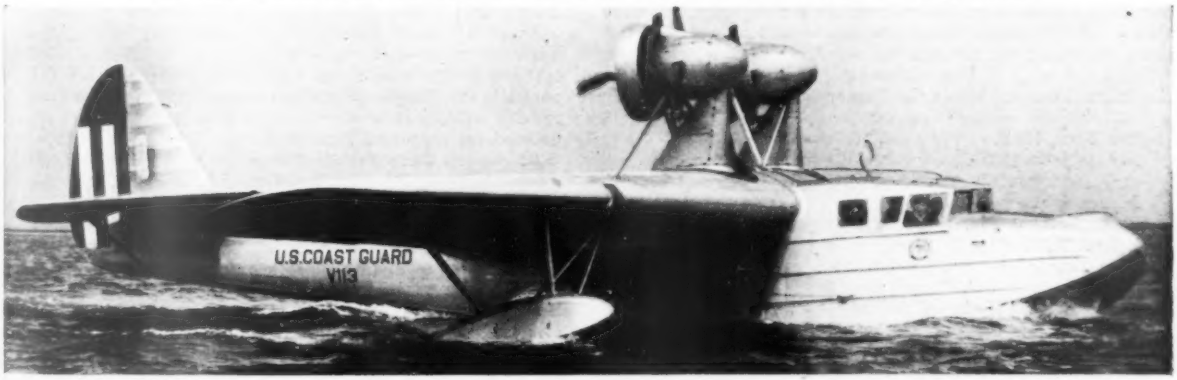
Still widely used is Grumman JF-2 three-place amphibian. Planes mostly are bought by Navy and transferred to Guard.

Hall PH-3 is a modern revised version of an old Navy patrol boat. Its specialty is long range, heavy duty in open seas.



Recently placed in Coast Guard service are several Grumman J4F-1's. This is a smaller, Ranger-powered version of JRF-2.

Coast Guard aviation history was made with Fokker PJ-1 flying boats, nicknamed "The Flying Lifeboat."



Used also by Coast Guard is the Curtiss SOC-4, Navy scout-observation type. Note left wing slot open in a semi-stall.

This Waco seaplane was carried aboard Coast Guard cutter, put overboard by derrick for operations in Alaskan waters.

Flown until recently on inshore patrol work, this old Viking 00-1 flying boat was facetiously dubbed "Good Ship Lollipop."

With this financial impetus, a site at Ten Pound Island, Gloucester, Mass., was selected for the first Coast Guard air station. After contracts were let for the planes, however, there was no money available for the building of a hangar. As a temporary measure, a canvas hangar was borrowed from the Army.

The site selected was rocky, difficult of access and had about all the disadvantages that one could find for an air station. But at least it was another start toward the goal for which the air-minded officers were working—an aviation branch in the Coast Guard.

The canvas hangar was used only a short time, until funds were obtained for the building of a frame structure. The station at Gloucester had been in commission about a year when arrangements were made for a portion of the Naval air station at Cape May, N. J., to be loaned to the Coast Guard for use as an air station. After this station was commissioned, growth was static until 1929, 1930 and 1931 when funds were appropriated for the purchase of five seaplanes and three amphibians.

With the acquisition of these new planes, the outlook for expansion in the aviation branch was considerably brighter. This optimism was shortly substantiated with the construction of six additional air stations fully complemented with planes and equipment. Later three more stations were erected along strategic coast line points.

Today the range of Coast Guard Air Stations is:

Salem, Mass. (replaces the former air station at Gloucester.)
Brooklyn, N. Y.
Elizabeth City, N.C. (replaces the former air station at Cape May.)
Miami, Fla.
St. Petersburg, Fla.
Biloxi, Miss.
San Diego, Cal.
San Francisco, Cal.
Port Angeles, Wash.

In addition, there is an Air Patrol Detachment located at Traverse City, Mich., for the purpose of determining a suitable location for an air station in the Great Lakes area. A Coast Guard plane is also assigned to the Coast Guard district commander at Jacksonville, Fla., and another plane is assigned to the senior Coast Guard officer, 14th Naval District, Honolulu.

One has only to contrast the rocky site and flimsy canvas hangar of 1925 with today's efficiently operated modern air stations with complete facilities, to realize the tremendous strides taken by the Coast Guard in its aviation branch.

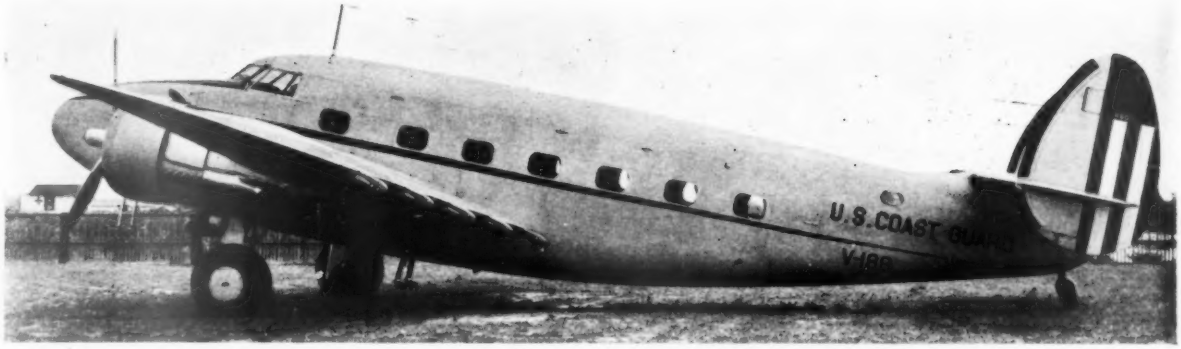
While this building program was under way the training of personnel was not neglected. Night and day, Coast Guard pilots fly over land and sea, in all kinds of weather on hundreds of missions. The Coast Guard is essentially a sea-going service at all times, and, since it becomes a part of the Navy in time of war, and therefore a part of National Defense, it is necessary that the personnel have training along Naval lines.

This is achieved through the co-operation of the Navy by training all Coast Guard aviators (commissioned officers after they have had at least three years of sea duty) and aviation pilots (selected enlisted men) at the Naval Air Station, Pensacola, Fla. These men are entered with the Navy students and receive identical training. Upon successful completion of the course, they are assigned to the various Coast Guard air stations.

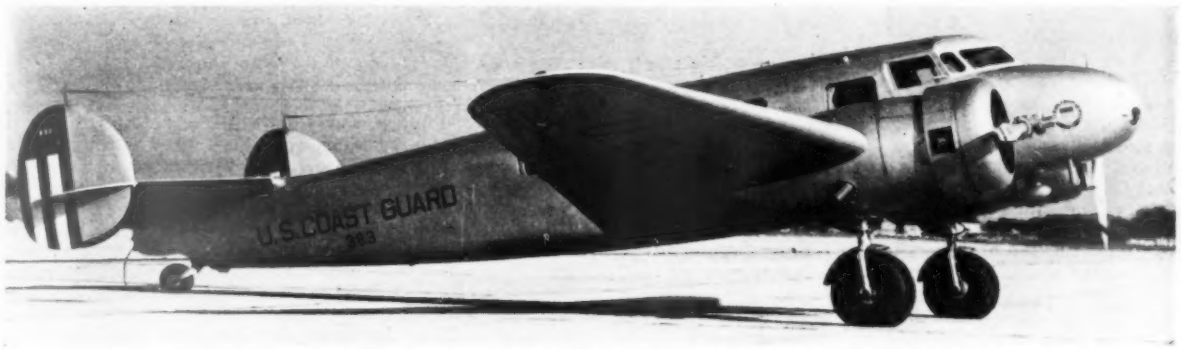
As an efficiency measure, within the past year a practice has been introduced where preliminary, or elimination flight training is given at Coast Guard air stations. This method parallels the Navy's system of determining, in advance of the regular training course, prospective trainees who are obviously unfitted for advanced flight training.

At present there are 62 officers, 200 enlisted men (aviation mechanics) and 56 aircraft assigned to aviation activities.

The maintenance of the airplanes and aircraft engines is handled by the enlisted men under the supervision of the maintenance officer, who is also an aviator. The enlisted men assigned to this duty are taken from the general service. Those showing initiative and ability were formerly sent to the Engine School & Repair Base at Norfolk, Va. for training in aircraft engine maintenance. This procedure, however, has been changed by the establishment of two overhaul bases at the air stations in San Diego and Elizabeth City. The enlisted



Latest high-speed landplane transport in Coast Guard is the Lockheed R50-1, better known as the "Lodestar." This 18-place plane is used largely for transportation of personnel around the U. S.



The official plane for Coast Guard headquarters in Washington has been this Lockheed R30-1, famed as the "Electra." R30-1 means: multi-engined transport plane, model No. 3, Lockheed-built, version No. 1.

men now receive their training in maintenance work at these stations.

Enlisted men have also been sent to Army and Navy service schools for instruction in their particular fields and to manufacturers' plants for further indoctrination in the maintenance and upkeep of aircraft engines and propellers.

For effective administration, each air station is placed under the jurisdiction of the commander of the Coast Guard district in which it is located. There are at present 18 districts, each connected with a communication network of telephone and telegraph lines, radio facilities on shore, aboard ships and in the planes, providing instant communication with virtually every unit of the service.

A Coast Guard air station is usually located for the operation of both land and seaplanes. None are situated directly on the open coast but utilize some body of water affording adequate shelter for take-off and landing of seaplanes. A typical layout will consist of a concrete ramp of adequate dimensions, mooring buoys, guiding lights and other facilities required by seaplanes. The ramp is directly connected to the paved space facing the hangar.

Peacetime activities of the Coast Guard entail sea law enforcement, search and rescue work, patrol, prevention of smuggling, survey of flooded areas and emergency transportation. Aircraft are chiefly used in these tasks.

With the occurrence of the present national emergency, the Coast Guard activities were enlarged to cover maintenance of a Neutrality Patrol, an Atlantic Weather Patrol and controlling the movement of ships anchoring in this country's waters, which included the supervision of loading and unloading explosives and other similar dangerous cargoes in our ports. The transfer of the Lighthouse Service from the Commerce Department to the Coast Guard entailed an additional task of servicing more than 30,000 aids to navigation.

Coast Guard aircraft in 1940 made 4,801 flights, totalling 13,231 hrs. in the air, cruising 1,258,344 miles. Seventy-six disabled vessels were located, 223 persons assisted, and 259 vessels and 1,466 persons warned of impending danger. Twelve persons were transported from disabled vessels and 113 medical cases were given transportation.

The foresight of the early exponents of airplanes for the Coast Guard Service has been amply justified. Planes are now an integral part of the organization. Its modern aircraft includes 13 long range, twin-engined patrol seaplanes, likened to a combination of the best qualities of a sturdy lifeboat and a transport plane. This type is used in coastal patrol, rescue and assistance work. There are 25 intermediate range, twin-engined amphibians, used in coastal patrol, rescue, flood relief, administrative, photographic and law enforcement work. In addition, there are eight inshore patrol single-engined planes, five training planes and five miscellaneous types. Of the cutters operated by the Coast Guard, two of the large 327 foot class carry planes.

National Defense is the keynote of American activity today. One of the four military services with which the nation entrusts its security, the Coast Guard has been actively preparing for any eventuality. Within the service there exists a spirit of co-operation difficult to duplicate. Called upon at all hours, day and night, to perform all manner of duties, by civilians as well as other Government departments, it complies with efficiency and dispatch.

EDITOR'S NOTE—The newspapers of this country recently reported that the President had ordered the transfer of the Coast Guard to the Navy. A little over 24 years ago, a similar news dispatch faced the newspaper readers of America.

On the morning of April 6, 1917, a dispatch was sent by radio and by land wire to every ship and shore station of the Coast Guard. This dispatch read: "Plan One. Acknowledge." It was sent out by Coast Guard Headquarters, a bureau of the Treasury Department. This message resulted in the instant augmentation of the forces of the Navy by 223 experienced and highly trained commissioned officers, approximately 4,500 experienced and competent warrant officers and enlisted men, 47 vessels of all classes and 279 stations scattered along the entire coast line of the United States.

Flown in from a ship at sea, this injured man is being rushed to a hospital. In 1940 the Coast Guard transported 113 medical cases in its airplanes, 12 of them being brought in from ships far out to sea.

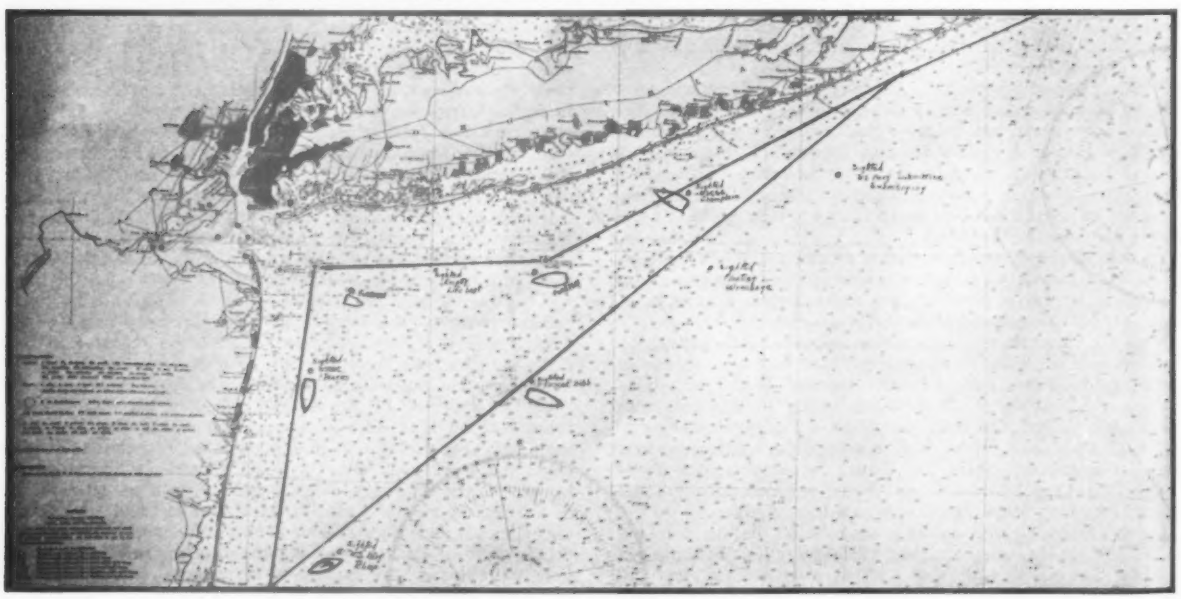
Within probably six hours after this message was flashed out by the Arlington radio station and was sped on the wires from Washington, the entire personnel and materiel of the Coast Guard, operating up to that moment under another department was functioning as a part of the Naval forces of the United States. It is of interest to note how this amalgamation, unique in the organization of the Federal Government, was brought about.

The Coast Guard was created by the Act of January 28, 1915, in lieu of the existing Revenue Cutter Service and the Life-Saving Service, and it was expressly stipulated in that Act that the Coast Guard shall constitute a part of the military forces of the United States and shall operate under the Treasury Department in time of peace, and as a part of the Navy, subject to the orders of the Secretary of the Navy, in time of war or when the President shall so direct.

In the sea-going branch of the Coast Guard, the cruising cutters are armed, a high state of efficiency is maintained in drills with rapid-fire guns and small arms, and complete Naval discipline is maintained. The Coast Guard stations, formerly life-saving stations, are placed at intervals along our entire coast line, and the warrant officers and enlisted men at these stations are, through long experience, admirably trained in maintaining a careful watch over all vessels within their sight and in promptly transmitting intelligent information regarding the movements of vessels and unusual occurrences within their observation. These stations are linked up with the Coast Guard's communication system, and information can be transmitted to Washington promptly and efficiently. With the exception of a few staff officers, all commissioned officers of the Coast Guard are graduates of the Coast Guard Academy where they have pursued a course of instruction quite similar to that given at the Naval Academy. Most important of all, the Coast Guard personnel is imbued with military tradition and a fine *esprit de corps*, the inevitable result of high ideals and devotion to duty covering over a century and a quarter.

When in the spring of 1917 it appeared probable that the unjustifiable actions of the German Government might involve this country in war, a conference was held between officers of the Navy and officers of the Coast Guard, and a definite plan was evolved providing for the mobilization of the Coast Guard with the Navy. This plan, known as Plan One, was transmitted as a confidential document to each unit of the Coast Guard. It provided that upon notification by dispatch

Returning from patrol, a Coast Guard pilot carefully charts on a map everything he saw. This map records a Navy blimp, a submerging submarine, three Coast Guard cutters, floating wreckage, all off N. Y.



Hurricane warning blocks are dropped by planes to isolated towns, ships at sea.

A pilot plots the course he will fly to pick up injured person on fishing boat.

The plane's mechanic sometimes acts as co-pilot and observer on ocean patrols.

each unit should report to the appropriate superior officer and provision was made for working out all details necessary to prompt and efficient amalgamation.

So, on the morning of April 6, 1917, upon receipt of the telegram above mentioned, the entire Coast Guard was within a few hours a part of the United States Navy. Its personnel, officers and men, were prepared for any duty to which the Navy Department might see fit to assign them; its cruising vessels were ready, except for certain necessary additions to their armament, for active operations against the enemy.

In the early months of the war there was a tendency to follow the policy generally of keeping Coast Guard personnel on units of the Coast Guard or on vessels assigned to the Coast Guard. The Navy Department soon found, however, that the officers of the Coast Guard were especially qualified by education, ability, experience, and training to participate in Naval activities of practically every character and that the best result would be obtained by disposing of these officers in precisely the same way as officers of the regular Navy were utilized. This was done to a greater and greater extent as the war progressed, and with most satisfactory results.

It soon became evident that in this war there would be unlimited opportunity for work by small vessels. Indeed, one of the striking things about the operations of the Navy during the war is the fact that small vessels played a conspicuous and important part to an extent that probably no one had suspected they would be able to perform in a war between two great powers. There was urgent need on the other side for small vessels, easily maneuvered, that could keep the sea and be used in searching for and destroying submarines and in protecting convoys.

In August and September, 1917, six Coast Guard cutters, the *Ossipee, Seneca, Yamacraw, Algonquin, Manning* and *Tampa* left the United States to join our Naval forces in European waters. They constituted Squadron 2 of Division 6 of the patrol forces of the Atlantic Fleet and were based at Gibraltar. Throughout the war they escorted hundreds of vessels between Gibraltar and the British Isles, and also performed escort and patrol duty in the Mediterranean. The other cruising cutters performed escort and patrol duty in home waters, on important missions to Bermuda, the Azores, in the Caribbean Sea and off the coast of Nova Scotia, and operated generally under the orders of the commandants of the various Naval districts, or under the direct orders of the Chief of Naval Operations.

When war was declared there were in the Coast Guard 138 line officers, 70 engineer officers, 13 district superintendents, and two constructors, a total of 223 commissioned officers. Nothing can be more conclusive of the professional ability of the Coast Guard officers and of the confidence that the Navy Department imposed in them than the fact that of the 138 commissioned line officers of the Coast Guard, 24 commanded combatant ships of the Navy operating in the war zone in European waters, five commanded combatant ships attached to the American Patrol detachment in the Caribbean Sea, and 23 commanded combatant ships attached to Naval districts. Five Coast Guard officers commanded large training camps. Six officers performed aviation duty, two of them being in command of important air stations, one of these in France. The Navy Department, naturally enough, assigned to the command of combatant ships only officers whose experience and ability warranted such detail, and only those officers in whom the Department had implicit confidence. The large proportion of Coast Guard officers assigned to command duty is impressive. The former Commandant of the Coast Guard, Rear Adm. W. E. Reynolds, served as Chief of Staff of the 12th Naval District. Five Coast Guard officers performed responsible and important duty at the Navy Department in Washington. Officers not assigned to command served in practically every phase of Naval activity—on transports, on cruisers, cutters, patrol vessels, in Naval districts, as inspectors, at training camps and were of the utmost value to the Navy in that they required no training and were possessed of professional ability and wide experience that immediately brought them to the front. Officers of engineering ability and experience were urgently needed, and the 70 commissioned marine engineers of the Coast Guard contributed greatly toward filling that need.

Throughout the war, the Commandant of the Coast Guard was Commodore E. P. Berthold, who, with the necessary staff of officers at Coast Guard Headquarters in Washington, administered the affairs of the Coast Guard, under the direction of the Secretary of the Navy, in a most efficient and zealous manner.

As the war progressed, the value of the commissioned officers of the Coast Guard became more and more apparent to the Navy Department, and calls for them from all sides became more and more insistent. Shortly after the armistice, three Coast Guard officers were assigned to the command of large Naval transports engaged in bringing home the troops from France, and a number of other Coast Guard officers were assigned to transport duty. Of the 223 Coast Guard officers, seven met their death during the war as a result of enemy action, or 3.14 per cent of the entire commissioned strength. It is probable that the percentage of deaths due directly to enemy action among regular officers was greater in the Coast Guard than in any other branch of the military and Naval service. Considering all officers and enlisted men, the percentage of battle losses in the Coast Guard was 1.74 per cent; the percentage of battle losses in the Army, excluding Marines, was 1.42 per cent.

It is of interest to note that the first United States vessel to pass the great German fortification at Helgoland and through the Kiel Canal after the signing of the Armistice was the

(*Continued on page* 254)

The NAVAL AIRCRAFT FACTORY

Unusual to a fighting branch, the U. S. Navy builds some of its own planes, aero engines and accessories.

by Capt. E. M. PACE Jr.

Now on duty at the Naval Aircraft Factory as its manager, Captain Pace is no stranger to the huge plant in Philadelphia, having served there 1919-1923 and again 1932. Naval Academy graduate in 1912, he returned in 1914 for a post-graduate course in Naval architecture, finished at M.I.T. Born in Calvert, Tex., April 23, 1891, was awarded Victory Medal in World War I.

PRIOR to World War I the airplane was a thing of experiment. True, short hops had expanded to spectacular flights and improved design had made scheduled trips a certainty, but the plane had not been a deciding force in any battle.

However, at the time of the United States' entrance into the war, the airplane had become recognized as a powerful potential weapon. Demands for its production were increasing.

Due to its infancy (and somewhat experimental status) the aircraft industry naturally had no huge reserve supply from which this country could draw. Manufacturing of airplanes had been small and sporadic.

In order to face this problem of aircraft supply, the Navy Department, in June 1917, directed Lieut. Comm. Coburn of the Construction Corps to survey the possibilities of building a Naval aircraft factory capable of producing 1,000 planes per year.

The site selected was the Philadelphia Navy Yard, and ground was broken August 10, 1917. The plant was completed 110 days later, at an approximate cost of $1,000,000.

The main building of the original plant was 400 feet square and contained a balanced aircraft factory, i.e., mill, metal shop, panel shop, covering, varnish and dope rooms, hull shop and final assembly, together with general offices, toilet and locker rooms, cafeteria and store rooms. In addition, there was a four-cell dry kiln, a brick building heated for the storage of kiln dried lumber, a boiler house and a lumber yard for the accommodation of approximately 3,000,000 feet of lumber.

In December 1917, the Navy Department having practically quadrupled its flying boat program, enlargement of the factory was undertaken. The expansion was completed on July 6, 1918, at a cost of approximately $3,750,000.

More difficult than the problem of providing the plant and its equipment was that of assembling its working force and directive personnel. The aircraft industry was in its infancy and skilled men were scarce. During the entire war there were never in the Naval Aircraft Factory as many as 25 employees who previously had worked on aircraft. Most of the employees, including superintendents, inspectors, engineers and foremen had to be trained from the ground up in their particular job.

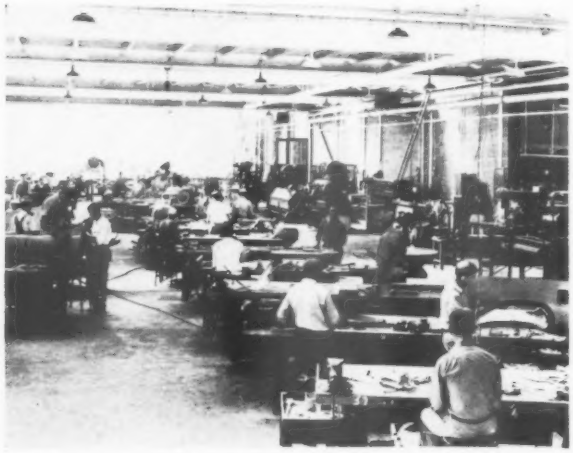
Recruiting of this civilian force began early in September,

Building No. 75 at the Naval Aircraft Factory is the administration building. In these offices the author and his staff run the 24-year-old factory.

In this final assembly and repair hangar can be seen Navy-built N3N-3 trainers (foreground), miscellaneous fighters, dive bombers and utility types. Factory also builds a scout bomber and patrol bomber.

Adjoining Mustin Field is the final assembly shop, one of the largest buildings at the Factory.

In the Factory's aeronautical engine laboratory, latest and experimental devices are tested for possible use by the Navy.



Metal parts for Navy aircraft are fabricated in this cowling shop. Men at left are building up tail section of N3N.

1917, and on October 27, 1918, the personnel of the factory reached its highest mark of 3,654 employees. By January 1, 1919, this figure had dropped to 2,034 employees, and it is estimated that the turnover involved the hiring of more than 6,000 employees.

The initial production assigned the Naval Aircraft Factory was the H-16 flying boat. The order was placed on November 20, 1917, and 151 days after the receipt of plans the first H-16 airplane was given its initial flight test. On April 2, 1918, the first two planes of this type were shipped to England. The F5L was later substituted for the H-16 in production. First deliveries of H-16 airplanes were at the rate of two per week. At the signing of the Armistice, two F5L airplanes per day were being delivered.

Following the Armistice, the working force of the factory was rapidly reduced and for many years was stabilized at approximately 1,400 men. Since the passage of the Vinson-Trammel Bill, March 27, 1934, requiring the manufacture of airplanes and engines in a Government owned plant, this force has been increased steadily until it now numbers approximately 4,600.

Activities of the factory have undergone a radical change in the last 20 years. The end of the World War left the Navy with a large surplus of patrol planes, but with practically none of the other types of airplanes necessary to a well-balanced Naval aviation program. Production of patrol planes was terminated as quickly as possible. A limited production of new types was ordered, and a considerable number of existing airplanes were modified to a type suitable for Navy use. This entailed considerable change in the factory organization and disclosed the need for development of new materials, new manufacturing processes and new conceptions of design. As a result, laboratories were established in which this development could be carried out. In 1924 the aeronautical engine laboratory, formerly at the Navy Yard in Washington, was transferred to the Naval Aircraft Factory in order that it could work more closely with the other aircraft developments.

During the building of the rigid airship *Shenandoah*, assembled at Lakehurst, N. J., the shops of the Naval Aircraft Factory were used to fabricate the structure and the cars for the *Shenandoah*. The experience thus gained in the working of light alloys pointed the way to the introduction of metal construction in heavier-than-air craft. The factory then built a patrol plane similar to the F5L, in metal, which demonstrated important savings in dead weight of structure by the use of light alloys in plane construction. As a result, a wider use of metal for construction material was stimulated. The processes developed for the fabrication of this material were made available to the aircraft industry, contributing to a rapid introduction of metal construction.

During the course of these years considerable stress was placed upon the development of facilities for operating airplanes with the Fleet. An important feature in this program was the catapult for launching airplanes from ships, developed at the Naval Aircraft Factory. The group of men who carried out this work became the nucleus for a section now devoted entirely to this type of work.

Little-known seamstresses play an important role in Naval aviation. This girl is one of several parachute specialists.

The aeronautical materials laboratory occupies a large part of the Naval Aircraft Factory's new air-conditioned building.

Aircraft paints are so important there is a special laboratory at the NAF where new formulas are devised and tested.

Engine parts inspections are conducted in this section. Both NAF-built and commercial engines must pass these inspectors.

As the Naval Aircraft Factory developed, it continually faced new problems. New methods were introduced and organizational changes were frequent, in order to meet the changed requirements, and a basic framework of organization gradually evolved. This organization proved itself to be basically sound by the comparative ease with which the factory has been able to absorb a greatly increased working force within the past two years.

The factory is administered by a manager, under the command of the Commandant of the Navy Yard, Philadelphia. Attached to the manager's office is a schedule section which budgets the funds allotted the various departments and prepares master schedules co-ordinating various department activities. In addition there is an intelligence officer to take care of security details; a personnel section and a central files section.

The principal departments of the factory are supply, engineering, production, accounting, inspection, plant and flight.

The supply officer administers the supply and accounting department. These departments purchase, store, issue and account for all material required in the operation of the factory. Much of this material is purchased as required for specific jobs. Stocks of the more standard materials are maintained, and these supplies are replenished as they become depleted. The factory also acts as central procurement and distribution agency for all aircraft materials required in the Naval aviation organization.

Each unit requisitions the material it will require for some definite period, such as six months. Ordinarily the material is delivered direct from the contractor to the requisitioning station, but some items are stocked at the Naval Aircraft Factory and stations are supplied by delivery from the factory storehouses. Additions are being made to storage facilities at certain conveniently located stations on the Atlantic and Pacific coasts and it is anticipated that, in the future, only a small amount of stock for other activities will be kept in storehouses at the factory. However, the central procurement and stock control will continue to be administered by the supply department.

For accounting purposes, materials are divided into classes, each class containing material of similar nature. In order to spread the stock procurement and replenishment work as evenly as possible throughout the year, certain classes of material are assigned to each month and procurement is initiated in this month. Minimum stocks are determined primarily by past issues. However, in setting these stock limits, account is taken of the time required to secure delivery of the particular material.

The engineering department, due to the large amount of experimental and development work, is relatively much larger than the engineering department of a privately owned manufacturing plant whose primary function is production.

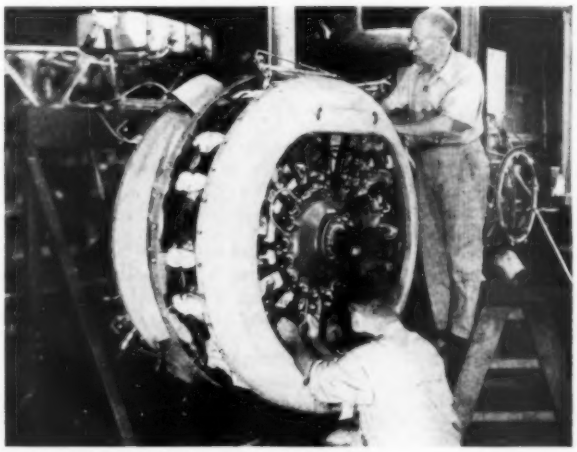
In addition to the design staff, drafting and blueprint sections, the engineering department operates all the laboratories, which comprise the following:

1. Aeronautical Engine Laboratory, covering the test and development of engines and all manner of power

(*Continued on page 208*)

Normal repair and maintenance work is handled by the NAF instrument shop. Future plans call for new experimental work.

Commercially-built engines, like this Wright "Cyclone," go to NAF, then are installed on Navy-built SBN scout bombers.



MAINTENANCE

Much of the skill of Navy mechanics is due to their wide experience on all types of planes.

A crippled plane is a serious handicap to land base or carrier. Back of Naval aviation's performance record stand the skilled artisans of the Maintenance Division.

by Comm.
V. H. SCHAEFFER

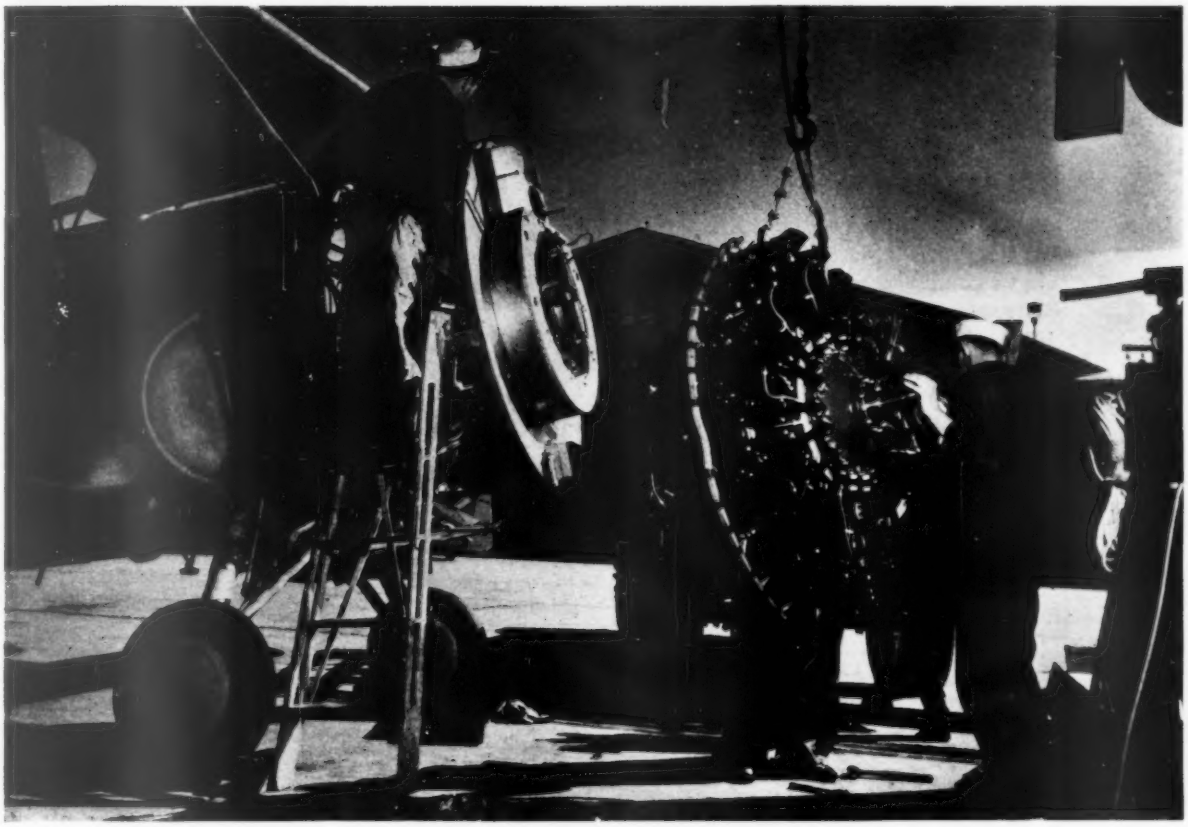
Born in Dayton, O., May 29, 1897, and now head of Maintenance Division, Bureau of Aeronautics, Commander Schaeffer was graduated from the Naval Academy in 1918, designated Naval Aviator in 1921. Made first Naval flight over Grand Canyon, led 20-plane transfer Norfolk-Panama in 1931. Prior to his present post, Commander Schaeffer was air officer of the U.S.S. Lexington.

AIRCRAFT maintenance, as the term implies, is that phase of aviation activity that pertains to maintaining aircraft in operation. It covers a broad field of endeavor. In general it includes those measures necessary to prevent failure in service of the airplane, its engine and their component parts. It covers the inspections necessary to determine that the aircraft is in a satisfactory state of operating condition, general maintenance practices to preserve as far as possible the airplane and engine in proper flying condition, periodic overhaul to correct any defects in materiel which have developed and to replace worn out parts.

A primary function of maintenance is not only to effect repairs expeditiously after failures have occurred, but by thorough methods of inspection and adequate preservative measures to prevent as far as possible such failures from occurring, thereby reducing to a minimum the necessity of removing aircraft from operation due to minor troubles. "Keep 'em flying" is the motto of the maintenance men.

The maintenance of Naval aircraft in the United States Navy involves the problem of sustaining thousands of planes operating from aircraft carriers, from the decks of cruisers and battleships, and from far-flung advanced bases in the Atlantic and Pacific oceans. Wide dispersion of operating units complicates this problem. It is necessary that Fleet aircraft be maintained in operation for long periods of time away from shore bases and shore overhaul facilities. This means that the Fleet squadrons must be self-sustaining to the greatest possible extent. Aboard ship only limited facilities are available for repair work. Material failures must be reduced to a minimum. With Naval aircraft operating over the wide expanses of oceans, a forced landing, particularly of a landplane, may very probably result in the complete loss of the airplane and, possibly, loss of life. One of the primary functions of operating maintenance is to find and correct defects before they can cause serious trouble.

Naval aircraft maintenance afloat depends primarily upon the work performed by the aircraft overhaul bases ashore. These bases are located at various points on the Atlantic and the Pacific coasts within the continental limits of the United States and at strategic points in the outlying United States possessions. Routine airplane and engine overhauls and major repair work are performed at these bases at periodical intervals and more frequently when necessary. However, Naval aviation units operating from ships at sea must of necessity be self-sustaining to the extent of performing minor repair



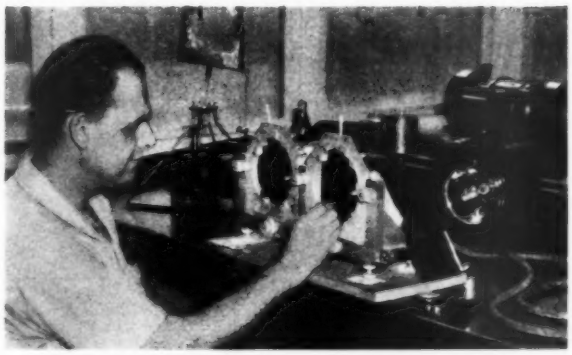
Mechanics overhauling this Curtiss SBC-4 must know its highly complicated structure forward and backward.

and maintenance work within the limits of the facilities available aboard the ships from which these airplanes operate.

Naval aircraft must be prepared at all times to operate in any area where the United States Navy is ordered to go. Maintaining such planes in operation presents many additional problems to those of operating from shore bases. Personnel of Naval aircraft squadrons must be qualified for and prepared to handle all problems of repair maintenance as well as operating maintenance. This requires a highly trained squadron organization of officers and enlisted men. A plane which is out of commission on board ship, not only reduces the effective operating strength of that unit but is also very much in the way. Because of the limited space, planes unable to fly interfere with the operations of the remaining planes.

Highly trained personnel are required as Naval aviation mechanics. They form the backbone of the maintenance organization afloat. The "unsung heroes" of the spark plug, wrench and grease-gun are the ones upon whom major reliance is placed to keep the airplanes flying. They must be qualified to perform highly skilled aircraft mechanical work of all kinds, work which would otherwise be done at the repair bases if the aircraft squadrons were operating ashore. They receive their preliminary training as aircraft mechanics at the Navy Trade Schools, after which they are rotated on tours of shore duty at the different overhaul bases, where they learn to take an airplane and engine apart, repair them and put them together again. For this reason it has been made a matter of policy to have enlisted men form a portion of the working organization at the overhaul bases.

Of primary importance in maintaining aircraft in operation in the Fleet are the regular checks and inspections performed by the personnel of the operating units. The responsibility for thorough inspection rests with the personnel of the activity to which the plane is attached. Inspection forms are provided as an aid and check-off list for the personnel performing the work. Each day before any flights are made in an aircraft, it is inspected and a daily flight inspection form is filled out by



Calibration of directional gyro (above) and magnaflux inspection of propeller part (below) require high skill.

New recruits are thoroughly trained in engine construction. Navy planes average major overhaul every 18 months.

Instructor watches closely as class members attach wing to F4B-4 at Jacksonville Naval Air Station trade school.

Crack mechanics can replace an engine in a little under two hours. Below, a "Cyclone" is installed in a Grumman FF-2.

the plane captain. It is, in general, a visual check of the parts of the plane which are readily accessible for inspection to determine that everything is satisfactory. The pilot of the plane is required to satisfy himself that this inspection has been properly made and to state that he accepts the plane for flight. Upon completion of the flight, the pilot records on this inspection form any defects noted which he considers should be remedied before the next flight.

At the end of each 30 hours of flight operation a more complete and thorough inspection is conducted. This involves a complete going over of the plane and engine to determine that all parts are in good condition and functioning properly.

Other and more frequent inspections are conducted when necessary, or in case any chronic difficulties in a particular type of plane have developed.

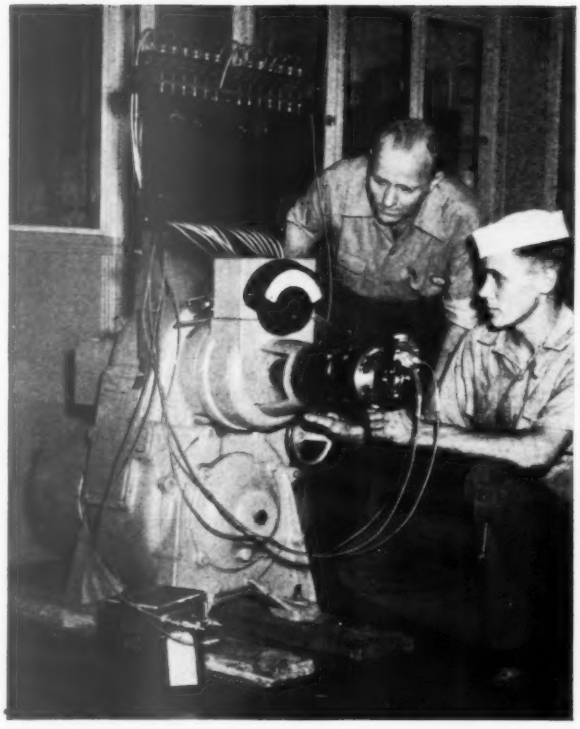
The co-ordination of maintenance activities afloat and ashore is under the cognizance of the Maintenance Division of the Bureau of Aeronautics. Under the supervision and direction of the Chief of the Bureau of Aeronautics, this division is responsible for the maintenance, overhaul and repair of Naval and Marine Corps aircraft and all matters pertaining thereto.

This division supervises the supply of aeronautical material required for maintenance and operating purposes.

Requisitions for material come from the operating and overhaul activities to the Bureau of Aeronautics, where they are acted upon by the Maintenance Division. Materiel is issued from stocks on hand at the supply depots or new procurement is initiated as may be required. Records are kept of past issues of various classes. Based upon these records, future requirements are estimated so that material may be procured and on hand when needed.

In the Expenditures and Costs Section of the Maintenance Division, records are kept of all operating and overhaul costs and incidental expenditures. These records provide data upon which budget estimates are based for submission to Congress to cover the funds that will be required for maintenance purposes.

Materiel failures are reported by operating activities to the Bureau of Aeronautics on report forms which have been prepared for that purpose.



Maintenance personnel are on the alert to remedy defects before trouble occurs. Here aircraft generator is tested.

Planes operating at sea face corrosion from salt air and spray. Metal surfaces are minutely examined for weakness.

Engines are completely dismantled for close study of parts. Constant watch must be kept for indications of corrosion.

An Aircraft Trouble Report is submitted whenever an aircraft accident occurs by the activity to which the airplane or engine is assigned. An aircraft accident is defined as an occurrence which takes place while an aircraft is being operated as such and as a result of which a person or persons are injured or killed, or when an aircraft receives appreciable or marked damage as a result of the failure of the aircraft structure or engine, or through the forces of external contact or fire. Appreciable or marked damage is defined as damage to the aircraft which necessitates the replacement of a major assembly, or assemblies, such as wing panels, landing gears, etc.

These reports cover all matters pertaining to the cause of the accident and recommendation by the operating activity as to action which should be taken in the matter. Materiel failures which do not fall under the category of aircraft accidents as defined above are reported on a form designated as "Report of Unsatisfactory or Defective Materiel."

Photographs of the failed part and of temporary repairs incorporated, if any, or sketches of repairs recommended form part of these reports. Where practicable, failed parts, properly identified, are boxed and shipped to the Bureau of Aeronautics for examination. These reports are carefully analyzed in the Bureau and remedial action as necessary is taken. Copies of the reports, when appropriate, are sent to the manufacturers who may be concerned in the matter, for their comment and recommendation. Pertinent information and instruction on the subject in the form of technical orders, notes and bulletins are issued to all activities concerned with the operation of that type of aircraft.

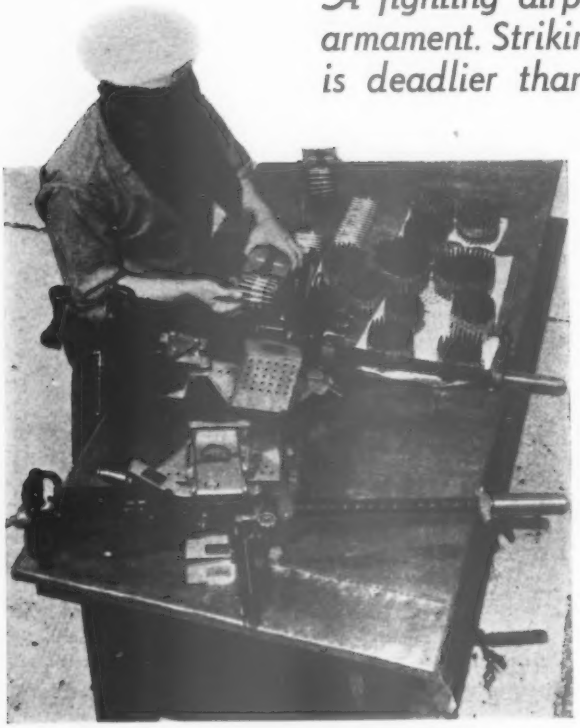
Overhaul schedules are prepared to co-ordinate and equalize the overhaul workload between the various bases. As far as possible, Fleet aircraft are overhauled at the nearest base. It frequently becomes necessary, however, to transfer planes from one base to another for overhaul because of the fluctuating workloads. This is accomplished where possible by flying planes to bases where the work can be done most expeditiously and economically.

It has been determined by experience that Naval airplanes require major overhaul on an average of every 18 months.

(*Continued on page* 186)

ARMAMENT

A fighting airplane is only as good as its armament. Striking power of U.S. Navy planes is deadlier than that of any other nation.



These .30 caliber machine guns now are used largely for practice. Bullet tips are colored to leave marks on sleeve targets.

Navy armament engineers have done much pioneering in the development of gun turrets like that above, in a patrol bomber.

THIS business of arming airplanes is said to have begun in earnest during the early stages of World War I when an impetuous French pilot lobbed a well aimed rock into the path of a passing German flyer. Previously it had been the pleasant custom for aviators of the opposing sides to wave a fraternal greeting upon meeting each other going or returning from reconnaissance flights over the enemy's lines. Since that moment the aircraft armament race has been on.

But here in the United States the development pace was slow during the 20 relatively peaceful years following the Armistice. Experimental funds were meager. The aircraft industry was not armament conscious. The armament boys were as popular as a case of measles—they were the misguided fellows who insisted on including a few guns and bombs in an airplane, thereby producing a crate out of a design which might otherwise have made a good airplane.

Few people accepted the fact that the primary justification for the existence of a military airplane lies in the armament it is capable of carrying. Consequently, until two years ago our fighters ("pursuit planes" to landlubbers) mounted only one .30 and one .50 caliber fixed guns—little better than the batteries carried by the Spads and Fokkers of the first World War. Comparatively recently our patrol planes were defended by four manually operated guns and the largest bomb load carried by any Navy service type was 4,000 pounds.

Actually it took the impetus of the present European war threat to start the transition which has revolutionized the art of designing military aircraft. Where guns and bombs formerly were fitted into any place which could be found *after* an airplane had been designed, it is now the usual practice to build an airplane around its armament from the very inception of the design. Attention is focused on the performance guarantees in the battle-ready condition with guns trained out for use and bomb-bay doors open, whereas previously a design had been evaluated in the so-called clean condition which meant actually a peacetime condition.

Increased engine performance and improved design practices have made it possible to carry more guns, ammunition and bombs so that now the Navy is producing fighters mounting four or more hard-hitting .50 caliber guns.

Patrol bombers are protected by five or six separate gun stations with single or twin .50 caliber flexible guns, usually in an enclosed power-operated mount, at each station. Recently the Navy began flying a seaplane equipped to deliver a load of more than 15 tons of bombs over a target thousands of miles from the point of take-off!

In the rapid development of the last few years many radical changes have been introduced in the field of aircraft ordnance material. We have been fortunate in being in a position, as ringside observers of the European war, to benefit from a full scale test of these changes. We have been reassured to find that many of the fundamental principles and policies evolved by the U. S. Navy in connection with aircraft armament and its tactical use—principles and policies arrived at long before the outbreak of hostilities—have now been adopted by the belligerents and proven sound as the war in the air has progressed.

It is impossible to give details about the armament installations of current types of Naval aircraft without violating the secrecy necessary in the interests of our national defense. However, a general discussion of the armament carried by Naval aircraft may serve to answer in part the question so often heard: "How do our planes stack up with those of the British and Germans?"

by Comm. W. F. BOONE

In charge of the Bureau of Aeronautics' armament section, Commander Boone went to London in 1940. As assistant Naval attache, observed advances in armament material and aircraft gunnery in actual war operations, came home and applied lessons to protection of U. S. Naval aircraft. A Naval Academy graduate in 1920, he was born in Berkeley, Cal., February 14, 1898.

Before we start, it must be realized that the Navy operates two general classes of combatant aircraft: (1) those which take off from the water and (2) those which are launched from ships. Patrol bombers—the large flying boats—represent the former class. In the latter category ship-based types are further subdivided into (a) carrier planes and (b) scout observation seaplanes catapulted from battleships and cruisers.

There seems to be no size limit for the former class. Therefore if we need to carry more guns, bombs and torpedoes we simply design a bigger flying boat, but in the case of the second category there are very definite gross weight limitations such as the strength of carrier decks to take the landing impacts, the length of a carrier deck for take-off run, the number of planes which can be operated from a carrier and, for scout observation types, the size and capacity of catapults and hoisting cranes and the limited stowage space on deck.

Then, there is another important consideration. We divide the gross weight of an airplane into weight empty (the airplane itself) and useful load (the weight of the crew, fuel, oil, guns, bombs, ammunition and equipment which go into it). The weight empty of a carrier plane will form a larger percentage of the gross weight compared to a land-based plane, because into a carrier plane we must build arresting gear, greater strength in the entire structure to absorb the stresses of arrested landings, and weight must be allotted to inherent flotation, low landing speed devices, wing folding gear, etc. Thus the useful load is proportionately less, and, other things being equal, the percentage of gross weight available for armament is correspondingly reduced. Nevertheless, the Navy's latest carrier fighters, dive bombers and torpedo planes are equal or superior in performance and striking power to any corresponding foreign types of comparable size, shore or ship based, now in service.

Long ago the Navy realized that the .30 caliber gun lacked sufficient wallop. Far sighted Navy ballisticians could see that the aircraft version of the *Monitor-Merrimac* epic was bound to happen—that sooner or later some unsporting soul, taking a tip from the pilot in the World War I who slipped a stove lid into his seat, would install armor plate in an airplane and then a new contest between gun calibers and armor plate thickness would be on, just as it has been going on continuously in surface navies since the Civil War. It happened sooner than expected and we can see no limit to the size of the guns nor thickness of armor which aircraft of the future may be required to carry.

The Navy was the first to appreciate the value of the .50 caliber gun as an aircraft weapon, and took the lead in the wide use of it both as a fixed gun for fighters and a flexible gun for defense of bombers. With almost double the armor penetration capacity of a .30 caliber, it is a formidable aircraft weapon. Nine-tenths of an inch of the toughest face-hardened steel will not stop its armor-piercing projectile at point blank range. Yet we know that a few years hence we must abandon it in favor of a larger caliber gun. For that reason we are now prepared to install 20 mm. (0.8 inch) cannon in our fighters when the time comes.

One hears a great deal about the firepower of the *Spitfires* and *Hurricanes* with their batteries of eight .303 caliber fixed guns. What is "firepower?" Roughly speaking—and within the range of gun calibers with which we are dealing—it is the number of pounds of metal which can be hurled at the target in a given time interval.

One of our current carrier fighter types mounting four .50

Self-sealing tanks (above) covered by heavy armor plating (right) are standard on tactical U. S. Navy planes. Armor can deflect .30 and .50 caliber bullets.

Small practice bombs can be used many times. Shotgun shells fit into nose and are fired as bomb hits the target on ground.

Powerful parachute flares sometimes replace bombs on racks, are used in night maneuvers to illuminate targets for night bombers.

Water-filled practice bombs are used for purposes of economy. Those being "loaded" above are counterpart of 100 lb. bombs.

Cloth targets are towed by planes for aerial gunnery practice. The SBC-4 above is firing burst at sleeve, which later gets careful checking (right) for pilots' marksmanship.

caliber guns, for instance, has approximately twice the firepower of a *Spitfire* at short range. But there is more to the story. The .50 caliber bullet gets through structure and armor plate which stops a .30 caliber. It reaches the vital parts of the enemy airplane so that one .50 caliber hit is better than any number of .30 caliber hits which do not get through. There is a persistent report that one German bomber shot down in England had received 10,000 .303 caliber hits. The logical conclusion is that a somewhat smaller number of hits failed to down it.

The trajectory of a .50 caliber is flatter over battle ranges so that accuracy of aiming is greater. Furthermore, because of the increased mass of the larger bullet, it is not slowed down as fast by air resistance so that considering remaining velocity, the effectiveness of the four .50 caliber gun battery at a range of 1,000 yards becomes approximately five times that of the eight .303 gun installation, and this particular Navy fighter can continue to fire 2.8 times as long as the *Spitfire* due to its greater ammunition carrying capacity.

About a year ago the British armament experts began to feel that, due to the increasing use of armor protection appearing in German planes brought down in England, the time had come when it was necessary to increase the caliber of the guns in their fighter aircraft.

It was becoming increasingly difficult to wing a German pilot, particularly a very senior one, as the thickness of the armor carried by the German planes usually varied directly as the rank of the pilot. British fighter pilots knew they were getting hits yet enemy planes were absorbing the lead and flying away home.

Having available no gun of an intermediate caliber, it was necessary for the Air Ministry to jump to the 20 mm. Hispano-Suiza-Birkigt cannon, about an 0.8 caliber gun firing a projectile weighing 11 times that of the .303 caliber gun. Since the .303's had been doing all right until then, it would appear that the step-up to the 20 mm. cannon, with all of the attendant difficulties of installation and low rate of fire, was a greater change than was necessary for attacks on other aircraft, although justified if the use of fighters against tanks were contemplated. It appears that, except under very special circumstances, it will be some time before bombers can afford to carry armor plating and fuel tank protection which will defeat the .50 caliber bullet.

One of the principal considerations which led to the initial development and use of aircraft cannon was the desire to have a projectile large enough to permit the carrying of an explosive charge with a super-sensitive fuse. After a great deal of labor such a projectile was perfected, only to learn that the explosion, taking place near the skin of the target plane, did relatively little damage. Currently we find solid ball, armor piercing and incendiary cannon projectiles being used more generally than the explosive projectiles.

When we plot curves representing all of the factors which enter into the decision of choice of caliber for the fixed gun battery of a fighter, we find that the curves converge near the .60 caliber point, i.e., something on the order of a .60 caliber gun appears to be of the optimum size at the present time, and that is pretty close to our .50 caliber gun. Therefore, the choice of the .50 caliber gun for aircraft use, made a number of years ago, was a happy one.

It is significant to note that in the latest version of the famous Me-109 fighters, the Germans have removed the single 20 mm. cannon firing through the propeller hub and have substituted a new 0.6 caliber gun.

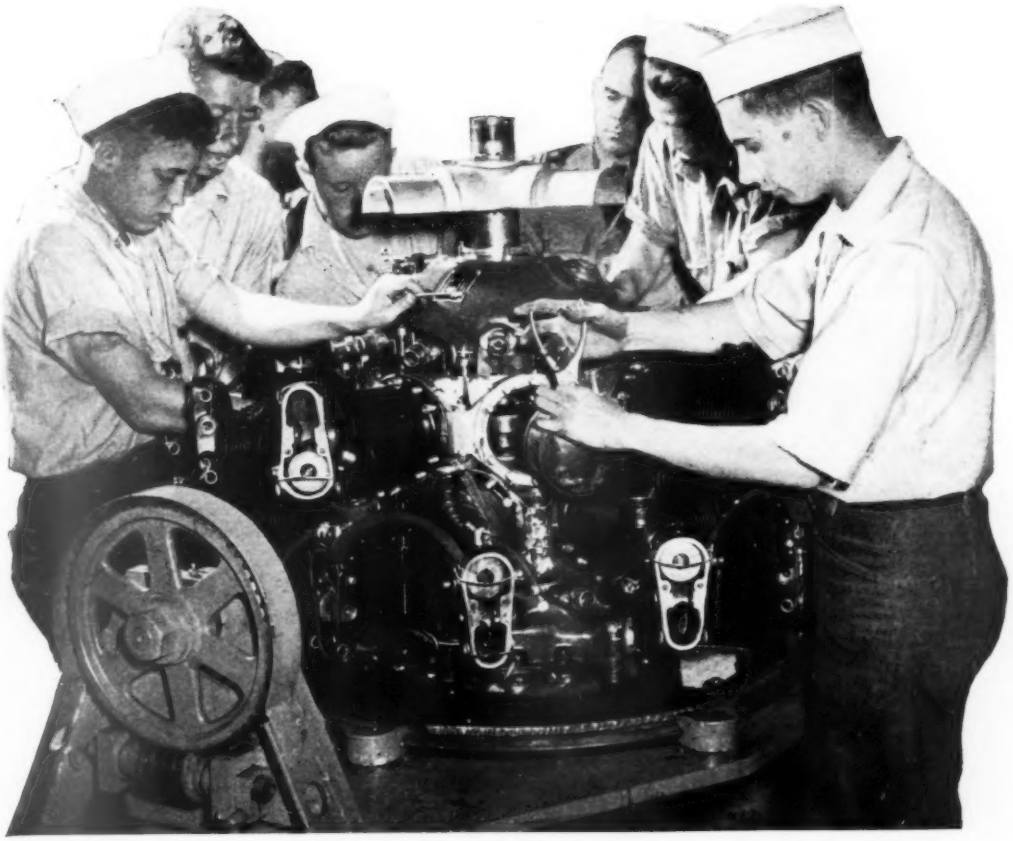
Our Government has made available to the British our .50 caliber gun. It was not well received at first due to the occurrence of many stoppages, but this situation was remedied as soon as British technicians became familiar with its adjustment and maintenance. Now the gun is more highly regarded and is constantly increasing in favor among the RAF pilots who have used it. British pilots are also beginning to like the synchronized fuselage guns in some of our single-engined fighters, because they "shoot right down the line of sight" and fill in the converging and diverging pattern of the wing guns.

So much has been written about dive bombing that there is nothing remaining to be said which *may* be said. The U. S. Navy pioneered in this form of attack, the effectiveness of which has been amply demonstrated at a frightful price to all those countries which have opposed Hitler.

With years of intensive training behind them, Navy pilots have developed skill and co-ordination in dive bombing technique not approached by any other service in the world. The armament and performance of Navy dive bombers has kept pace with this development, so that the new Navy types now in production will be capable of carrying very large armor piercing bombs and of releasing these at a maneuvering target with damaging accuracy. With bomb load expended, these dive bombers become formidable fighters, capable of delivering effective strafing attacks against surface targets and suitable for attacking with fixed or flexible guns any opposing types of aircraft except single purpose fighters.

(*Continued on page* 238)

The POWER PLANT



These Navy mechanics are overhauling a 14-cylinder air-cooled giant, the most modern type engine in use.

Operating thousands of aircraft over vast oceans calls for power plant efficiency unparalleled elsewhere in aviation.

by Comm.
RICO BOTTA

Born in Melbourne, Australia, November 2, 1890, Commander Botta enrolled in the Naval Reserve in 1917. The following year, while at the Naval Air Station, Pensacola, Fla., he was commissioned an ensign. Served as commanding officer, VP-7F and VP-2S at Coco Solo, C. Z., in 1931-32. Now in charge of power plant design section of the Bureau of Aeronautics, Engineering Division.

THE logical trend in the development of any type of aircraft is based on its utilitarian purpose. To the initiated their design and construction is just as diverse as the differences between a racing car, a pleasure car, a bus or a truck. Similarly, their engines may vary, but not in the same degree.

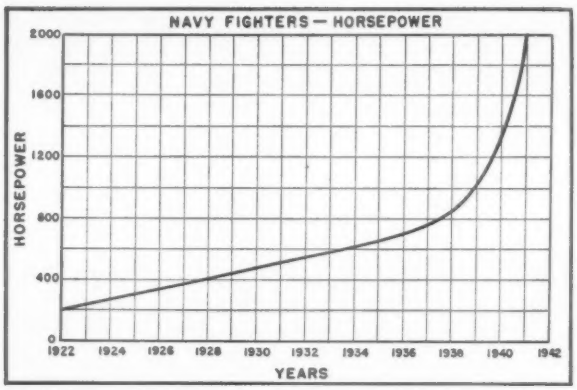
The sight of solid land under an airplane gives the pilot a comfortable feeling that regardless of his engine's condition or what might happen, everything will be all right. If he gets down safely he knows he can at least walk away, find shelter, food and probably facilities for communication with civilization and help.

However, as soon as he gets out of sight of land the behavior of his power plant becomes one of vital importance. Any unevenness in the steady rhythmic roar of the exhaust or the whine or whirr of the propeller is cause for startled concern. Three hundred, 30, or even three miles is a long way to swim in rough water and the potential damage a rough sea can do to an aircraft is inestimable. For that reason, from the years preceding our entry into World War I, when the Aeronautical Engine Laboratory at the Washington Navy Yard was the only Government aircraft engine testing laboratory in the United States, the Navy insisted on testing engines for reliability and durability.

Spectacular short high speed flights are of considerably less importance than the ability to go long distances, and what is more, come back home. The transatlantic flight of the NC boats immediately following the close of the first World War started a 20-odd year succession of long distance flights of patrol and carrier based planes, which were only made possible by a parallel development of reliable and economical engines.

The successful flight of the *Spirit of St. Louis* was no surprise to the personnel of the Bureau of Aeronautics, which had been endurance testing three Wright J-type engines simultaneously, correcting weak or defective parts as they

Power plant experts are also responsible for propellers. Here Navy officers study new Curtiss electric full-feathering prop.



In two decades, the Navy has increased the horsepower in its engines tenfold. Greatest strides have been made since 1940.

became apparent, with the assistance and co-operation of the Wright Aeronautical Corporation engineers, until a 50-hour full-throttle test without adjustments was accomplished.

It was the function of the Navy testing laboratory then, as now, to know, not to guess, what the engines could do. Engines were purchased under a policy laid down at the inception of the Bureau that the only criterion for purchase was to be performance and that alone. It was immaterial to the Bureau as to what the exact composition of a certain piece might be as long as it consistently retained the same composition and received exactly the same heat treatment and finish that the part which had passed the endurance test had received. From the original 25-hour endurance test before the war to the present 150-hour endurance test engines have been called on to produce and produce they must if the manufacturers wanted to retain Navy business.

The liquid-cooled engines installed in Naval aircraft at the period ending with the World War were not bad for their time. As the seaplanes became rugged enough to stand the shock of rough water landings, the engine cooling systems were just holding their own. But as soon as the planes based aboard the new carriers were brought to a sudden stop by arresting gears, the shake-up resulted in disclosures of weakness in plumbing, radiators and water jackets that were a serious source of trouble to their maintenance crews. A squadron with a large per cent of its operating planes undergoing repairs is of little value to the Fleet.

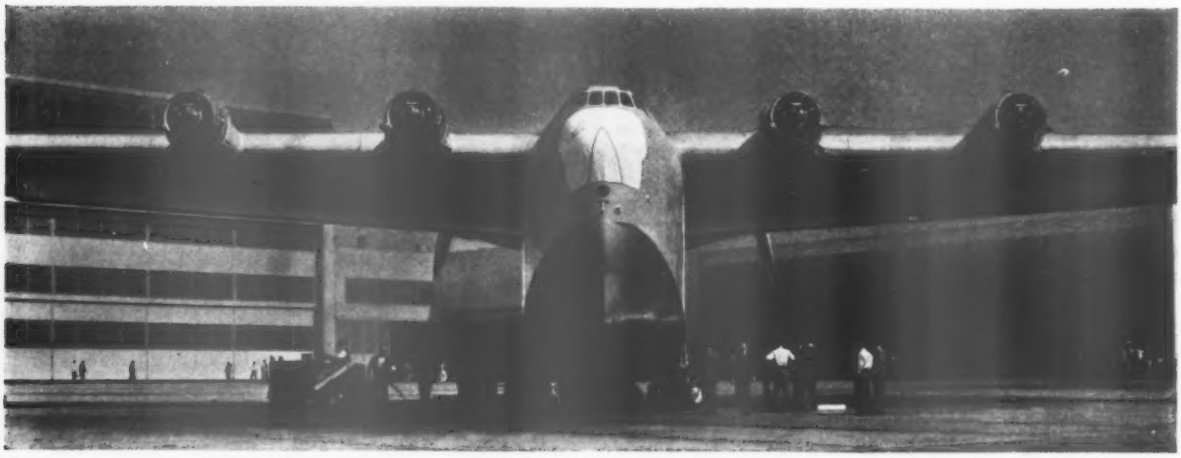
After a discouraging slow fight against failures and increased weight necessary to prevent failures, the Bureau decided to go full out for air-cooled engines of the radial type against the dire and now laughable predictions of others and our own ultra conservative flyers and technicians. The first air-cooled engines were the J series built by Charles Lanier Lawrance, whose firm eventually was merged with the company now known as the Wright Aeronautical Corporation. These engines were installed in the planes that went aboard the ships fitted with catapults for launching purposes. They were quite satisfactory except for power at altitude. To overcome this defect about 20 Vought OU-1 planes were fitted with positive displacement superchargers which increased their power and altitude performance considerably and were sent out to the operating units. As far as is known this was the first time that operating units were equipped with supercharged aircraft.

It was begrudgingly admitted by our non-service critics that, although it was possible to air-cool engines up to 35 h.p. per cylinder, that was the limit. That prediction has been extended many times until 135 h.p. per cylinder has been reached and the limitation prophets have become weary.

The consistent performance obtained during the early development was not achieved in the Navy alone. It was a cooperative effort. Manufacturers, Navy technicians, flyers and parts manufacturers all helped to make it a success. The Navy merely produced the directive force and sufficient money to provide the inspiration. The manufacturer had a considerable stake. In an endeavor to obtain a larger engine the Curtiss company in Buffalo built the R-1200, the Wright company the P-1, followed by the new Pratt & Whitney company with its R-1340 or *Wasp* engine. These were all single-row engines. As the latter was the most successful the former two developments were dropped. The powers increased rapidly and the displacement started to increase. The rivalry between the makers resulted in single row engines of 1,690; 1,750 and

(*Continued on page* 200)

Four mighty 2,000 h.p. Wright "Duplex Cyclones" furnish power for Martin XPB2M-1, world's biggest flying boat. Navy calls it the "Mars." It weighs 70 tons and is a third larger than largest clipper.



PROCUREMENT and PRODUCTION

Manufacture of these PBY patrol bombers is supervised by Navy technical experts stationed at the factory.

Materiel Division transforms defense billions into the physical properties of a vastly enlarged Naval air service.

by Capt.
W. W. WEBSTER

With valuable experience gained as manager of the Naval Aircraft Factory, Captain Webster now heads the materiel branch, Bureau of Aeronautics. Born in Fargo, N. D., July 28, 1888, he was graduated from the Naval Academy in 1911, received degree of Master of Science from M.I.T. in 1916. Became Naval aviation observer in 1922, was designated a Naval Aviator in 1933.

THE Materiel Division of the Bureau of Aeronautics consists of three branches, Engineering, Procurement and Production. The Engineering Branch is the subject of a separate article in this edition and therefore will not be discussed further here except in its relations to the other two branches.

The Procurement and Production Branches are closely related to each other; the first is responsible primarily for purchasing and the second for production planning. Until very recently, they formed one branch known as Procurement, which was responsible for both of these phases of material procurement. However, the volume and complexity of the current expansion have necessitated the creation of a separate Production Branch which has been formed by two means: (a) a separation from other branches, principally Procurement, of certain production planning and co-ordinating functions, and (b) the creation of new sections to perform other functions heretofore non-existent but now made necessary, not only by the expansion of Naval aviation but also by the multifarious additional agencies and processes now added to the Government machinery in connection with production and procurement.

The Procurement Branch will continue its normal functions in the purchasing of airplanes, engines, accessories, equipment and all kinds of material, while the Production Branch will function largely as a staff to assist the head of the Materiel Branch in the co-ordination of matters leading up to procurement, such as liaison with other Government agencies and insuring the maintenance of scheduled production as far as possible.

Rather than attempt a detailed description of the duties of Procurement and Production Branches, it probably will be more enlightening merely to outline the organization of each and then describe in chronological order the general procurement procedure for an airplane contract, from initiation of the project to delivery in service.

Production Branch

With this in mind, the Production Branch consists of the following sections:

1. Schedule and Progress Section
2. Production Engineering Section
3. Priorities Section
4. Inspection Section

In addition to administering these functions, the head of the Branch and his assistants act as "conference," "committee" and "liaison" officers with the corresponding units of the Army,

Wheeled dollies speed movement of these Vought-Sikorsky "Kingfishers" (OS2U) down final assembly line.

Flotation life jackets must be worn by all Naval aviators. They are carefully tested for leakage before being released.

the Office of Production Management, the Scheduling Unit at Dayton, O., the Army-Navy Munitions Board and of other bureaus and offices of the Navy Department.

PROCUREMENT BRANCH

The Procurement Branch consists of the following sections:

1. Requisition Section
2. Contract Section
3. Plant Facilities Section
4. Costs and Changes Section

In addition to administering the foregoing, the Procurement Officer also represents the Bureau on various procurement committees. However, the most important of his duties is to conduct negotiations with manufacturers as to the terms and prices of prospective contracts for all quantity orders of airplanes, engines, accessories and equipment and also to pass upon preliminary negotiations conducted in the Engineering Branch for experimental contracts. These, of course, are all subject to the approval of the Chief of Bureau.

EMERGENCY PROCUREMENT CONDITIONS

Under normal conditions of supply and demand, after the number and model of a certain type of airplane to be obtained were determined by the Navy Department and the Chief of the Bureau of Aeronautics, the procurement procedure was simple and straightforward, requiring little explanation. However, in the present national defense program, where the demand is far greater than the supply and the aircraft industry is being expanded many fold, it soon became evident that the orderly placing of contracts for airplanes, engines and other material and for the construction of additional facilities, would have to be closely correlated between the Army and the Navy. In the early stages, the Airplane Section of the Advisory Commission to the Council of National Defense, and later the same Section in the Office of Production Management, served very efficiently in conducting this co-ordination.

The administrators of the National Defense Airplane Section met with representatives of the Army Air Corps and the Navy Bureau of Aeronautics and divided all existing airplane, engine and propeller contractors and the principal large accessory contractors into two groups under Army or Navy cognizance, respectively.

Cognizance was determined mainly by the service which would appear to have the majority of work in each particular plant based upon the then known original program of each

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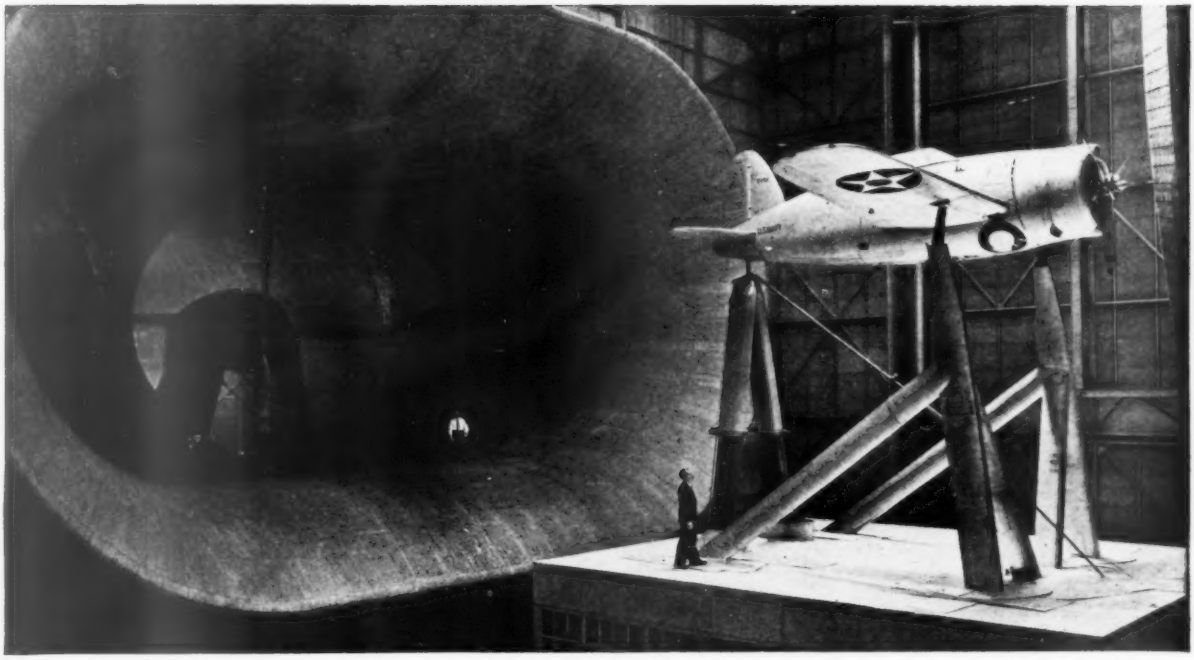


Experiment and Research

Full scale airplanes like this Brewster XF2A-1 are tested on balance scale of NACA wind tunnel.

So its bombers and fighters will be world's best, Navy maintains a large aviation research staff, also utilizing famed, progressive NACA.

by Comm.
L. C. STEVENS

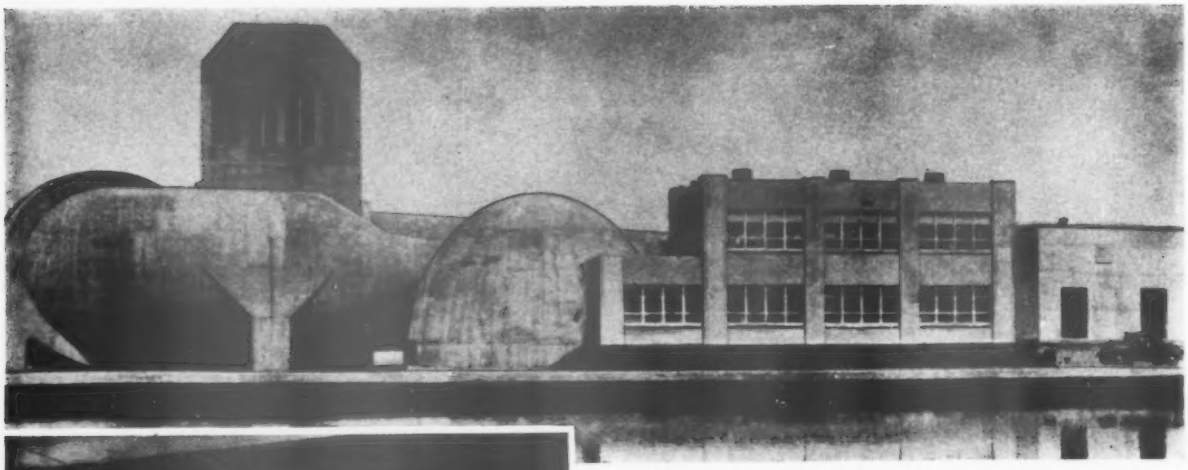
Now in charge of experiments and developments in the Bureau of Aeronautics, Commander Stevens was born in Kearney, Neb., February 19, 1895. He was graduated from the Naval Academy in 1918, in 1926 was assigned to study the application of aircraft to carriers and other ships. In 1934 and 1940 was assistant Naval attache for air at the American Embassy in London.

SOMEONE has said that only a hiccup is born full-grown. Nowhere is this saying more true than when applied to the modern airplane. Anyone who has seen the complexities that lie beneath the simple and graceful exterior of a modern high performance aircraft, or who has walked through the vast activity of a military airplane factory, will realize that squadrons of such intricate organisms as combat aircraft cannot possibly be brought into trouble-free existence in a single step.

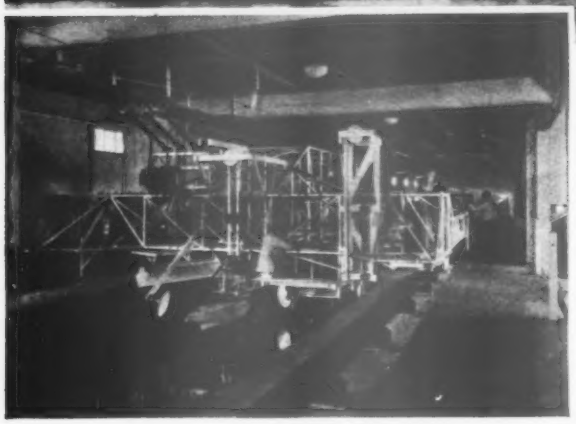
The prime objective of American Naval aviation is to have in actual existence the best possible air force in order to instrument national policy as occasions arise. A single airplane or one piece of equipment, no matter how good it may be, obviously must be regarded as a means to the end that it can be used in sufficient quantity to be really effective.

Because of technical advances due, in part, to the continuing efforts of Naval aviation, aircraft of the same size as those of a decade ago have, roughly, twice the weight and performance. Because the carrying capacity of ships is limited in space, it becomes necessary to obtain maximum performance, including armament, protection and reliability as well as such aspects as speed, climb and maneuverability, without appreciably reducing the number of aircraft that can be put to sea on ships.

With this increasing complexity, it has become necessary to use a great number of mechanisms within the airplane and to make as many of those as possible so automatic or self-contained that the pilot and crew will not have more than they can handle in combat. The result is that wings and fuselages are packed full of pumps, motors, wiring and controls—so full that should it be found that something cannot be made to function properly, the substitution of another scheme may involve a complete rearrangement of an airplane, extending even to modifications of the exterior envelope in which it is all packed. Should this occur, the delivery of finished aircraft to operating units would be sadly delayed. It, therefore, becomes necessary to go through a proving process in even conventional



Models and airfoils are "flown" in 500 m.p.h. blast of this NACA wind tunnel. At left is tank for testing hulls and floats.



Each new experimental type plane is tested in the air for stability, stalls and spins. Test pilots (at top) check flight board before trial flight. Later on in locker room record results, compare reports.

aircraft before they can be placed in service in any quantity.

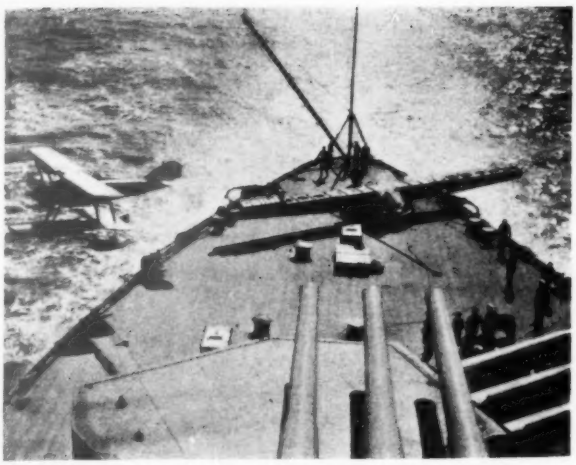
The same situation exists with regard to engines, fuels, equipment and all the components that enter into a finished airplane, extending even to the materials from which the various parts are made. Somewhere in the laboratories of this great industrial nation a new light alloy is found, or a synthetic plastic of sufficient strength and lightness to be of interest in aircraft engineering. The physical characteristics of the material must first be known—its tensile, compressive and sheer strength, its ductility and hardness, its resistance to corrosion and deterioration—then, means for working it and joining it together into efficient structures must be devised and proved. It would be unfortunate, to say the least, if several hundred airplanes using this new material should fall to pieces soon after they were placed in service, or should be found incapable of sustaining repairs. Consequently, a service test in small quantity may be necessary—all of which takes time.

There are high lift devices and power plant accessories known to the Navy, which, when finally fully developed and proved, will make further important advances in performance possible. Wind tunnel and bench tests provide an initial test, yet if the first applications made show unacceptable behavior in flight, this must be corrected before the goal of quantity application in service can be reached. This process sometimes takes years.

Experimental work has been compared to the hatching of eggs—it takes a certain amount of time and no amount of wishing or impatience will help. However, the Navy has long felt that at least the hen can be kept fed and warm and dry, or a properly controlled incubator can be provided.

There is some confusion in most people's minds between research, experimentation and development. These terms overlap and perhaps they cannot be briefly and accurately defined. Still, experiment is nothing but test—the test of actual experience as opposed to something whose practicability or usefulness has already been fully demonstrated. For example, the Navy brings out a new power-operated machine gun turret and develops it, or tests it by experiment, until it is perfected. Then, it is decided that an existing model of patrol plane, now in production, can have its defensive armament considerably enhanced by the application of this particular turret. Studies show that its installation in this particular model is practicable and there is no question as to the usefulness of the result. A production change to incorporate the turret would be a development, becoming experimental only in case the practicability and usefulness were in doubt, in which case a single airplane or a small number of airplanes would embody the turret as an experiment.

On the other hand, research is a persistent effort to discover facts, or to co-ordinate them as laws. Naval aviation is not a research organization but is, rather, an organization for the military application of research. This does not mean that it is not interested in research. On the contrary, it formulates



Among many aviation devices pioneered by the U. S. Navy was the catapult, now used throughout world. Above is early catapult.

many research problems, particularly through wide representation on many special and permanent committees and, if need arises, finances specific research in universities, other branches of the Government and elsewhere. The Navy, however, does conduct some research. Under the law, the National Advisory Committee for Aeronautics is the principal research agency for aeronautical problems. The Bureau of Aeronautics holds membership in the committee itself, employing fully its excellent and expanding facilities. Research at the NACA may indicate the value of a new high lift device or method of cowling engines. Experiment by the Navy might show its practicability and desirability, and once in service it might undergo a considerable amount of development leading to further improvement in new designs.

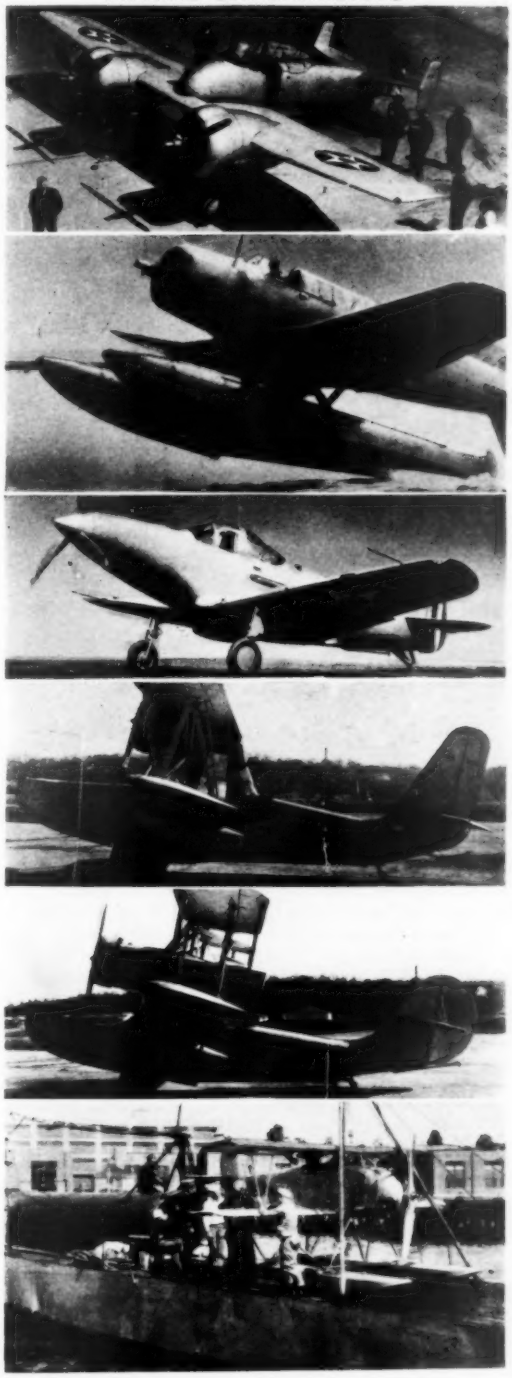
By Act of Congress in 1926, the National Advisory Committee for Aeronautics was given another function. An Aeronautical Patents and Design Board was set up to consider, on behalf of the Government, questions as to the use and value of aeronautical inventions submitted to any branch of the Government. The recently-organized National Inventors' Council is also available for the appraisal of inventions. The Navy is very much interested in ideas for improvement and increased effectiveness of its aviation material but, unless an idea is highly specialized and is peculiar to Naval needs, it should be referred to one of the above organizations.

Few people realize that to be different is not enough. Any difference in the way things are done must carry with it definite advantages in order to be of interest. The Navy has scores of proposals for methods of arresting aircraft on carriers, many of which are different from those now in use and some of which could doubtless have been developed into a system as satisfactory as that now in service. It has, however, taken 20 years of time and many millions of dollars to develop the present system to its high state of efficiency and a little thought will bring the realization that a new system must carry with it reasonable assurance of being able to accomplish things of value that are not now accomplished in order to warrant abandoning the successful continued effort of years to undertake a new line.

The number of ideas which are submitted over and over again as new is not surprising when one considers the hold that aviation has on the American imagination and the complexity of the field which does not make it easy to know what is current practice and what is not. It should be realized that there are tens of thousands of university-trained engineers who are devoting their entire lives to aviation, who are keen and intelligent and who have a background of information and understanding to guide their thought.

Most of the proposals which are received fall down for lack of such background and particularly because of lack of engineering education which will give a quantitative idea of what is involved. The limitations of such modern devices as photoelectric cells and infrared devices are seldom under-

NAVAL EXPERIMENTS



Constant experimentation, exemplified by these photographs, is being conducted by Naval aviation experts. From top to bottom are a few examples: The Grumman XF5F twin-engined fighter, still undergoing tests; a seaplane version of the Vought-Sikorsky "Vindicator"; the Bell XFL-1 ("Airabonita") proposed shipboard fighter, similar to Bell's famed Army "Airacobra" but without the tricycle landing gear; the Great Lakes XSG-1 scout amphibian of 1932; the Loening XS2L-1, similar to the XSG-1; and a tiny, collapsible seaplane, first tested after the World War, for use on U. S. submarines. Note "hangar" tube in background.

Designed, built and flown first in miniature (left), Martin PBM became first-line patrol bomber, now known in Navy as "Mariner."

stood. Even an elementary knowledge of physics will frequently disclose fatal defects, but more often the effects of weight and space are not appreciated. In aircraft engineering, as well as in life in general, one cannot get something for nothing and, too often, the disadvantages outweigh the advantages of what seems at first consideration to be a grand idea.

There is no dearth of good ideas—what is needed is an organization which can bring an idea to successful completion in a form where it can be tried and utilized. The Navy is fully occupied with necessary and urgent work. Its activities would have to be far more extensive than they are at present for the Navy to build all that it would like to see built in an experimental way. Because of the difficulties of diverting raw materials, tools, equipment and personnel from current programs of known importance, it can only sponsor ideas which it really believes have genuine promise of successful application to Naval problems.

In experimental airplanes are embodied the research, experimentation and development of power plants, equipment and components, which is the culmination of years of work along many lines, but these planes are regarded by the Navy only as a step towards aircraft in service in quantity. Sometimes the road may be long and difficult, in which case the enhancement of service usefulness must be correspondingly great, but the end is always kept in view. The new giant flying boat built at the Martin plant would never have been undertaken if it had not been definitely known that it would require an airplane of that size to do the things which it will be able to do. A step-by-step development takes years of time and, unless the goal is high, other developments during these years will pass it by.

Most experimental airplanes for the Navy are definite prototypes from which to learn directly the lessons that are necessary for rapid and orderly production. They are brought into existence as the result of the recognition of their possibilities in extending in time of war the striking power or the versatility of Naval aviation. Sufficient studies are made by the Navy itself to know that it is possible for the industry to build a design whose capabilities are beyond those possessed by existing aircraft. This may be possible by incorporation of new engines, armament or other equipment, perhaps by the application of recent aerodynamic research, or because of a new conception of what the Fleet can or should do. These studies are carried far enough to determine the approximate performance, the size and weight, in order to determine whether or not the resulting airplane if successful as such can really be employed by the Navy. As a result of this preliminary work, a descriptive specification is prepared which establishes only the limitations necessary for Naval use and to insure that the design will give the desired results. Meanwhile, another totally different line of experiment and development is underway to lighten the stringent Naval limitations as much as that may be possible and a balance must be sought between present facts and future hopes.

The specification in effect establishes an envelope within which designers are given maximum freedom for the exercise of their originality and ingenuity as regards arrangements and choice of engines and other components. This specification, since it embodies the most recent viewpoints of the Navy, is sent only to competent designers and manufacturers whose integrity is known and who have satisfied the Navy that they have reasonable ability to carry the job through to successful completion. There is sufficient pride in the American industry, coupled with the desire to remain in production on its own product, to provide keen competition on the designs which are submitted to the Navy in accordance with the type specification. From these designs, the most outstanding are selected, and contracts for experimental aircraft are negotiated. Usually duplicate experimental airplanes are built, in order that the long and complicated process of testing may proceed on both airplanes simultaneously, and so that loss or damage will not introduce delay.

Due to the internal complexity of modern aircraft and to the extraordinary space limitations, it is impossible to work out the best detailed arrangement of equipment and controls completely on the drafting boards. For this reason and also because such questions as vision for combat and for carrier landings and accessibility for servicing of armament and other

(*Continued on page* 224)

PHOTOGRAPHY

Recording what the "eyes of the Fleet" see is vital task of aerial photographer.

by Lieut. Comm. Robert S. Quackenbush, Jr.

Indicative of photography's importance in modern warfare was recent observation tour of England by Lieutenant Commander Quackenbush, until recently in charge of BuAero photo section. Born in Cornwall, N. Y., he is Naval Academy graduate (1927), was designated Naval Aviator in 1929. He now is establishing specialized photographic schools, based on European observations.

AERIAL photography in the present war has assumed proportions that were unheard of a few years ago. Photography in all its branches has achieved perfection in the United States that has not been surpassed by any other country in the world. Its use has become so universal and so diversified that it enters practically every phase of our daily life.

Very early in the present European conflict, the medium of photography, formerly confined to the fields of journalism, advertising and entertainment was quickly recognized as an indispensable war implement.

It has been revealed by authoritative sources that all belligerents are using aerial photography in every type of operation. Pilots and camera men, trained for their highly technical task of reconnaissance photography, make daily trips for a film record of seaports, airdromes, industrial cities, railroad terminals and other military objectives.

Skilled interpreters examine minutely every detail of these photographs. The results achieved by this film translation are remarkable. Interpretations evaluate activities of shipping, building schedules of ships and concentrations of aircraft. The production of certain manufacturing centers may be calculated, troop and supply movement predicted and camouflage broken down. The result is, the possessor of the photographs knows nearly as much as the enemy.

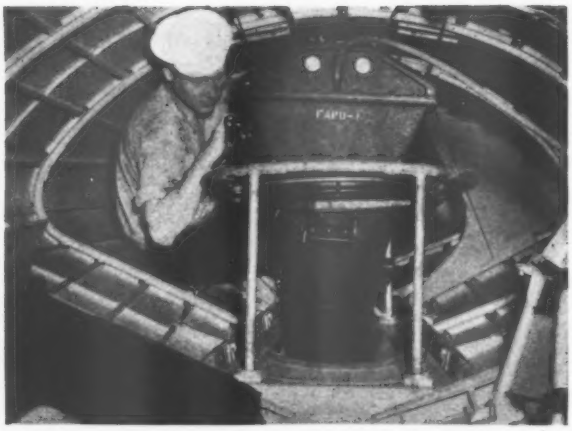
It is conceivable that our Fleet units and aircraft may be required to operate in areas where existing maps are inaccurate, incomplete and unsuited for planning purposes. Into this category fall many of the Pacific islands, the northeastern area of North America, including Newfoundland and Greenland, and much of the coastal areas of Alaska and the Aleutian Islands. The same absence of adequate maps exists for most of the Bahamas, much of the Caribbean area and a large percentage of both the Atlantic and Pacific coastal areas of Mexico, Central and South America and outlying island areas.

It would appear from this that the Navy must know how to photograph these areas and compile maps and map statistics from the photographs. The organization required for this technical work is extensive, composed of highly trained officers and men, whose field of activity is wide and diversified.

Military cartography entails all the details of map making, correction, revision and map statistics. The aircraft camera

A photography class at Navy school emphasizes use of aerial camera in all phases of tactical flying.

The Naval aviation photographer's range of equipment runs from the small newspaper camera to the giant aerial mapper.



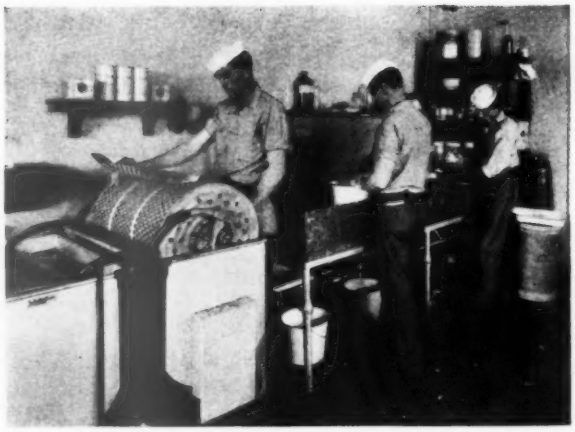
Fairchild mapping camera installation in PBY-5. Action is automatic. Swivel holder compensates for movement.

Printing department at Norfolk Naval Air Station. Aerial photographs now have important role in tactical operations.

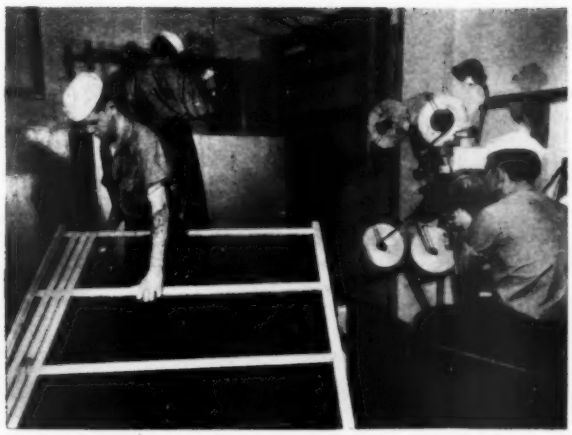
Photographing parts from aircraft for closer examination or record purposes. This is customary when accidents occur.

Roll film from an aerial camera is developed and on the drying racks a few minutes after the plane returns to its base.

Camera storage room at Norfolk laboratory holds fortune in lens equipment. Darkroom chemicals occupy bins at left.



Production line principle is applied in finishing room as prints follow steady course through developers and baths.



Motion pictures are used to record events and tests important to Naval aviation. These men are processing movie films.

also enters the field of military intelligence, recording camouflage deplacement and detection, location and selection of targets. For operational information, details are recorded on damage assessment of bombing and shell fire, deployment of enemy facilities, identification of ships and convoys.

In addition to military work, the camera of the Navy photographer covers all fields of both still and motion pictures. Records are made of all tests and experimental work. New designs of equipment are photographed for detailed study. Fleet maneuvers and target practice for both surface ships and aircraft are only some of the routine assignments. In addition, aerial surveys for other departments of the Government and motion picture training films for all bureaus of the Navy department are made. For example, during the period of 1936 to 1939, Naval photographers photographed for the hydrographic office, over various sections of the Western Hemisphere, 14,000 linear miles with single lens mapping cameras and 4,700 miles with multiple lens mapping cameras; 34,000 square miles were covered with single lens cameras and 44,000 square miles with multiple lens cameras. During the present year the Galapagos Islands, the entire western coast of Ecuador and several thousand miles in Central America have also been photographed for the hydrographic office.

Official photography within the Naval aviation organization had its inception at Pensacola, Fla., in 1914. The principal work at that time consisted of making a photographic record of plane tests, instrument installations and similar routine work. Cameras used were comparable to those used by newspaper photographers.

This type of work gradually increased in volume. In March, 1916, however, a new activity was introduced. Aerial photographs were requested of old Fort Morgan prior to its use as a target for experimental firing practice by the *U.S.S. New York* and *U.S.S. Arkansas*. Good photographs were secured on this mission by using a Graflex camera with an adaptation of cigar box pieces around the bellows which protected it from wind blasts. The results of this flight indicated that a special handheld aerial camera was necessary. The result was the production of the first handheld aerial camera to be manufactured in the United States.

This camera was successfully tested in December, 1916. From that time on, aerial photography was added to the ever increasing volume of ground photography. By 1917 the volume of work had increased to such an extent that a photographic section was established. The official photographer at Pensacola was selected to organize this section. The value and necessity of photography as a function of the Navy became more and more apparent as the work load increased and additional reliance was placed upon its results. A school was established at Miami, Fla., and many of its graduates were sent to U. S. Naval air stations abroad during the World War.

After the Armistice, practically all the photographic personnel returned to civilian life and the section was reorganized with the school located at Anacostia, D. C. This school was later transferred to the Naval Air Station, Pensacola, in 1921 in order that more flying facilities would be available for photographic training. This has continued to be the location of this school.

With the exception of a few isolated cases, the Bureau of Aeronautics administers all Naval photographic activities. The central office for this administration is in the Bureau of Aeronautics. The officer-in-charge is a Naval aviator with wide photographic experience. He is assisted by other Naval aviators with similar experience and other Naval officers and technicians, whose experience and background in the motion picture industry fit them for this work. Here policies are determined, funds provided, personnel procured, allowances determined and materials and equipment furnished to the many photographic laboratories and units in the Fleet. Modern, up-to-date laboratories are maintained at all Naval air stations, in all aircraft carriers, all aircraft tenders, each battleship and each new cruiser. In addition to these laboratories, there are special shore establishments such as the Naval Academy, Naval Proving Ground, Dahlgren, Va., and the Naval Torpedo Training Station, Newport, R. I., equipped with photographic laboratories.

Mobile photographic reconnaissance units, mobile utility squadrons and units of the Fleet Marine Force are provided with elaborate photographic units. Each laboratory is in the charge of an officer who is a graduate of the Naval School of Photography. The size and scope of each laboratory is, of course, dependent upon its local requirements and military usefulness.

The aerial cameras used by the Naval photographer vary in size and focal lengths, but in general may be used for either vertical or oblique photography. The standard aerial camera used by the Navy and the Marine Corps is a product of many years of research, study and improvement. It is known as the F-56, designed by the Navy. This camera is electrically operated and contains a between-the-lens shutter of speeds up to 1/300th of a second and is furnished in focal lengths of 5¼", 8¼", 20" and 40". It uses roll film up to 225 exposures, 7" by 7" negative size. Aperture openings vary from F.4 in the 8¼" to F.8 in the 40". It is possible to take photographs as rapidly as one every second with these cameras.

In addition to the standard cameras, other cameras of Army design are also utilized. These are the standard night with a focal length of 13½" known as the K-19 and a K-18 which produces a 9" by 18" negative with 24" focal length and the T3A camera which is the multiple five lens camera of 6" focal length. Other focal lengths used are 7½", 10" and 12".

The most recent product in handheld cameras was developed by the Navy through the facilities of the Fairchild Aviation Corporation and is known as the F-48 handheld aerial camera. This camera is light in weight (approximately seven pounds) has roll film, between-the-lens shutter with speeds up to 1/500th of a second, 4" by 5" negative. It has the very desirable feature of being practically foolproof. Anyone who can read or write, aim and sight the camera, can operate it. For

(*Continued on page* 248)

The Naval Air Station

The Navy air base at San Diego is a model community with every facility.

Equipped and manned with everything required to maintain a modern air fleet, the Naval Air Station is home port for the Navy's fighting aircraft and airmen.

Busiest spot on the base is this ultra-modern control tower which supervises all aircraft traffic at Norfolk, Va., station.

by Rear Adm.
BEN MOREELL

A graduate of Washington University in 1913, with a B.S. degree in civil engineering, Rear Admiral Moreell now is chief of the Bureau of Yards and Docks, also of civil engineers of the Navy. Born in Salt Lake City, U., September 14, 1892, he was appointed to the Navy in 1917. In 1932, he made a special study of European engineering, design and construction practices.

AT the close of the fiscal year 1938, (June 30, 1938) the Naval aviation shore establishment comprised seven (heavier-than-air) stations located at Pearl Harbor, T.H.; San Diego, Cal.; Seattle, Wash.; Coco Solo, C.Z.; Pensacola, Fla.; Hampton Roads (Norfolk), Va.; and Anacostia, D.C. These establishments represented a total investment of approximately $75,000,000 and provided facilities to support about 1,000 planes.

These stations were conceived and established because of the conditions brought about by the first World War.

Immediately following the Armistice of November 11, 1918, Naval aviation was faced with some of the most serious difficulties of its short career. Many pilots and skilled mechanics were leaving the service and air stations were being dismantled or left with skeleton crews to carry on routine operations.

Throughout the period from the close of World War I to June 30, 1938, improvements to these establishments were very limited. Hence, the Naval aviation shore establishment lagged behind and was woefully inadequate to meet the needs

of our rapidly developing and expanding aviation service.

Recognizing the inadequacy and deficiencies in the Naval shore establishment, the 75th Congress by the Act of May 17, 1938, (Public Number 528) authorized and directed the Secretary of the Navy to appoint a board to investigate and report upon the need, for purposes of national defense, of additional submarine, destroyer, mine and Naval air bases on the coasts of the United States, its territories and possessions.

On December 1, 1938, the Board headed by Rear Adm. A. J. Hepburn submitted its report which became the basic guide for the subsequent expansion of our peacetime shore establishment. The Board reported that the need for additional shore facilities for aircraft far outweighed those for destroyers, submarines and mines. It was noted that aviation shore establishments had failed to keep pace with the requirements of the planes authorized by law. It was recommended that a comprehensive and extensive building development be undertaken immediately to provide for the maintenance and operation of planes actually on hand.

Since that report was submitted, world conditions have so developed as to make imperative additional facilities far beyond those previously considered as the minimum essential for peacetime operations.

As a result, the seven stations previously mentioned have been increased to some 20 major operating, overhaul and training bases supplemented by many additional auxiliary fields and primary training stations. Where formerly the only insular Naval air station was located at Pearl Harbor, T.H., Naval air stations now extend along the Atlantic and Pacific coasts with a network of advanced stations extending westward across the Pacific from Hawaii to Midway and Wake Islands and on to the Philippines; southward from Hawaii to Johnston, Palmyra, and American Samoa; and northward from Seattle to Sitka, Kodiak and Unalaska. In the Atlantic, a similar network extends northeastward to Newfoundland and southward to Bermuda, Puerto Rico, St. Lucia, Antigua, Trinidad and British Guiana, and thence westward to the Canal Zone. In short, Naval air stations now gird the North American continent.

On the Atlantic coast principal air stations are now located at Quonset Point, R.I.; Lakehurst, N.J.; Norfolk, Va.; Anacostia, D.C., while on the Pacific coast principal stations are located at Seattle, Wash.; Alameda, Cal.; and San Diego, Cal. In the south aviation pilot training stations are located at Corpus Christi, Tex.; Pensacola, Jacksonville and Miami, Fla.

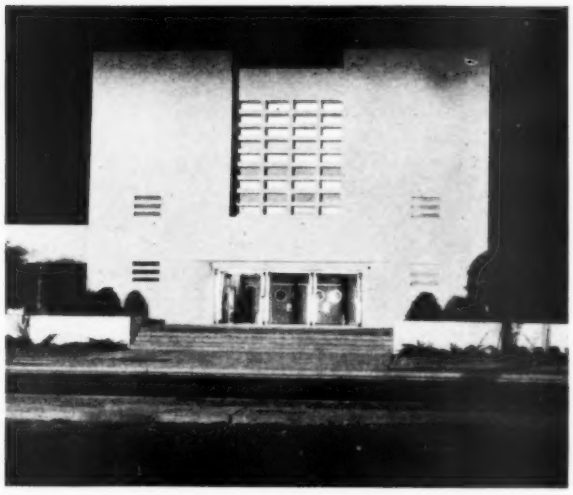
Actually, the major portion of the current aviation shore construction program will have been accomplished in two years, i.e., it will be completed by June 30, 1942. At that time the aviation shore establishment will represent an investment of more than $600,000,000 and will provide facilities to support more than 8,500 planes. This represents an expansion of 800 per cent in dollar value and 850 per cent in the planes supported since 1938.

The average American citizen has no clear concept of what comprises a Naval air station. This is natural and understandable as his concept would normally reflect personal observations and impressions gained from one of the municipal or commercial airports. It may be of interest, therefore, to give a descriptive picture of the equipment comprising a modern Naval air station.

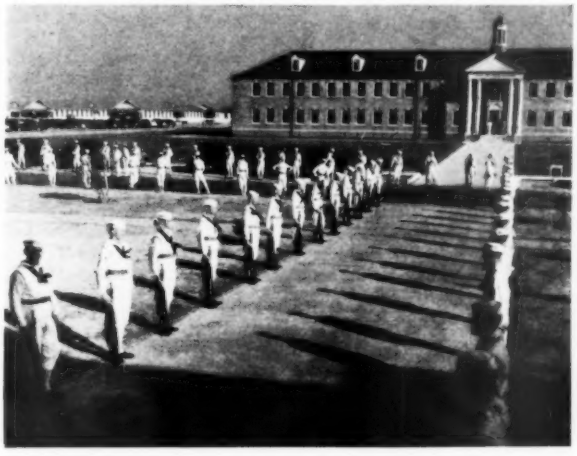
The ideal station will normally consist of a main station, three (possibly more) auxiliary base fields, and 20 to 25 additional outlying landing fields.

The main station will consist of 2,000 to 2,500 acres of land bordering a water area which is suitable for landing and taking off all types of seaplanes. The ideal main station will contain a seaplane operating area which will include an offshore water area and parking areas for seaplanes along the beach, with large seaplane hangars located directly inboard. Landplane facilities, including a landing field with taxiways, warming up platforms and hangars, will be located some distance away from the beach. This landplane area will occupy about one square mile and will be much larger than the average commercial or municipal airport.

Between the seaplane and the landplane areas will be located the industrial area, which will provide facilities for the major overhaul and upkeep of all types of planes; storehouses for aircraft and airplane engines and for general supplies of all

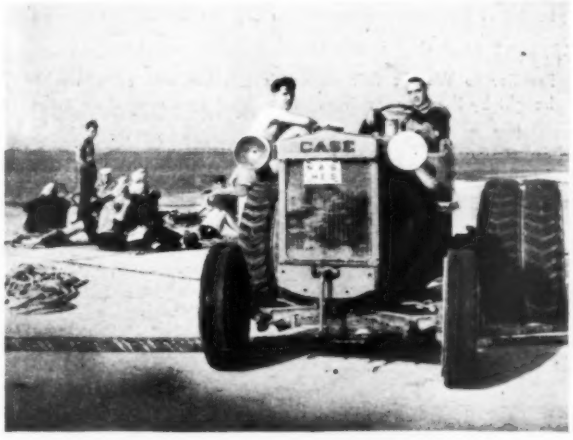


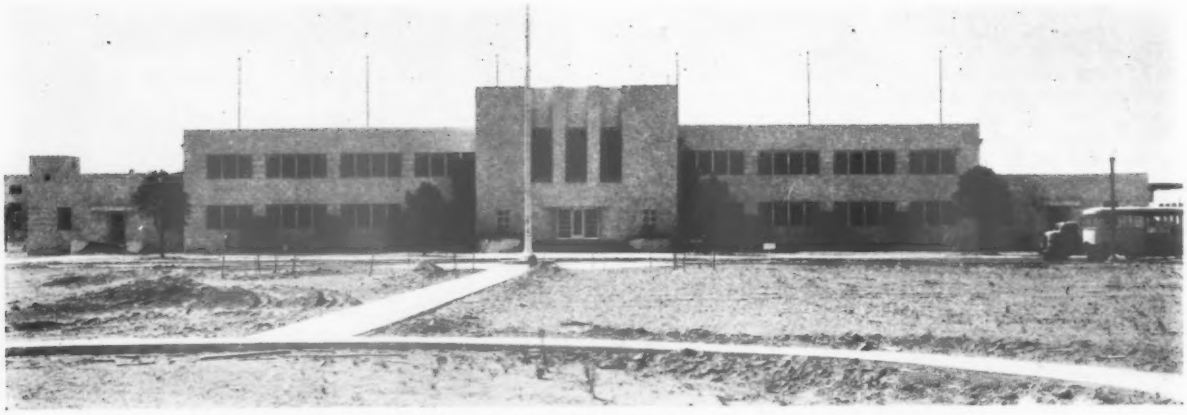
Equal to Hollywood's swank movie palaces is this theater on the Alameda, Cal., air station. Film programs as complete and varied as those shown anywhere, are a nightly feature at base.



The elaborate dispensary before which these sailors stand for inspection is the equal of the most modern hospitals in U. S.

Engineers of the Bureau of Yards and Docks must see that new air bases are complete, even to tractors for beaching bombers.



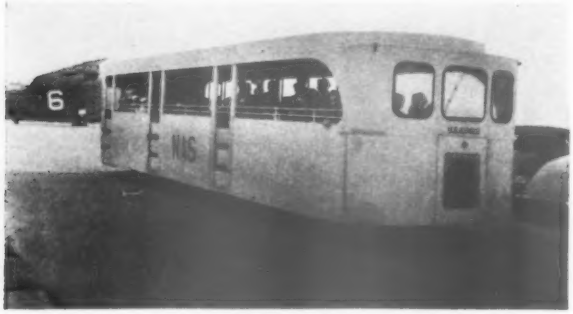


Station's nerve center, Alameda administration building typifies influence of modern design.

More hangars are needed to accommodate rapidly growing Naval air service. Above is one of the new group at Pensacola, Fla.

Married officers and families are quartered in these typical homes at Pensacola. Grounds are big, attractively landscaped.

Familiar to World's Fair visitors is this bus, one of a number bought by the Navy to transport enlisted men around air bases.



kinds; a power and cold storage plant; laundry; station garage; fire house and maintenance and repair shops.

Other areas will be devoted to the housing of personnel. It is customary to provide separate housing for enlisted men, for cadets at training stations, for married officers and bachelor officers. Barracks, mess halls and suitable recreational facilities will be provided for the enlisted men in a convenient area. Similar provisions will be made for cadets at those stations acting as training centers. Separate accommodations will be provided for bachelor officers and for married officers.

For each group recreational facilities will be provided in the form of tennis courts, hand ball courts, soft ball diamonds, swimming pools, ship service stores, library and recreational buildings. Generally speaking, each main station will be provided with one large gymnasium and with one large auditorium for the showing of motion pictures and stage shows.

Hospital and dispensary facilities for the care of the sick and injured, as well as an administration building, which is the nerve center of all Naval command operations, are a part of the station equipment. Also, no station would be complete without a radio transmitting and receiving station.

Three additional auxiliary base fields will normally be located within a radius of from five to 20 miles. Each will have an area of about one square mile and will be a complete and separate airport. In addition to a landing field, warming up platform and hangars, a power plant and other essential industrial facilities will be provided as well as certain personnel structures for enlisted men. A limited number of officers' quarters will be constructed. Here, also, recreational facilities will be provided to keep the men in the best physical condition and to maintain high morale.

There will be from seven to 10 outlying fields serving each of the auxiliary base fields. These outlying fields will contain from 120 to 250 acres or more (sometimes as much as 640 acres) and will be so located and distributed as to provide approximately three to four miles distance between each outlying field and the auxiliary base field. Each field will have some paved practice landing areas.

In the ideal layout for a Naval air station the auxiliary base fields would be distributed around the main station as the center of aviation operations, and the outlying fields would radiate from each of the auxiliary base fields. However, this ideal is rarely possible of attainment in practice because the main station must be located on a water area providing suitable space for seaplane operation.

The land area, over which the shore establishment of an operating air station and/or training station extends, must be quite large. This area can be visualized by thinking of a portion of land included by a segment of a circle having a central angle of about 90° to 120° and a radius which may be as much as 25 miles. The exact location of any Naval air station and/or training base will of necessity be governed by strategic and tactical considerations.

Possibly an improved concept of what constitutes the typical major Naval air station may be had by citing the following

This is part of the flight operations section of the giant Naval Air Station at San Diego. Blackboard lists pilots' assignments.

statistics. The entire station will occupy and utilize between 10,000 and 12,000 acres. It will provide paved landplane runways at least a mile long and with a minimum width of 300 feet. The paved area will be equivalent to about 515 miles of 18 foot wide highway. It will contain upwards of 300 buildings, possibly 25 to 30 miles of water distribution system, a like amount of storm and sanitary sewer system, and probably from 10 to 15 miles of railroad. It will also contain about 43 miles of electrical distribution system, from 10 to 15 miles of gasoline distribution system, 20 or more miles of station roads and a like amount of telephone cable.

The station will have pier facilities and other water front structures and be served by a deep water ship channel. In short, the modern Naval air station offers all the facilities required by a live, modern, self-contained American community of about 10,000 persons.

The Bureau of Yards and Docks of the Navy Department is the administrative agency charged with the responsibility for designing and providing all public works and public utilities comprising the Naval shore establishment. This Bureau was established in the Navy Department by authority of the Act of August 31, 1942, entitled "An Act to Reorganize the Navy Department of the United States." It is essentially the Public Works Agency for the Navy and Marine Corps.

The problems encountered in constructing the expanded Naval aviation shore establishment have been many and varied. The expansion of a station previously established and in active commission necessitates many compromises. In the latter case the difficulties encountered are generally due to: (1) the limited space available for expansion and (2) avoidance of conflict with the normal operations of the station.

In the construction of new stations within the continental limits of the United States entirely different construction problems arise. Here the ideal layout can be more nearly followed. But many difficulties are encountered because these new stations are generally located in areas not previously serving and supporting Naval activities. Hence problems arise concerning the acquisition of land, the evacuation of residents and the utilization of existing structures.

The problems of logistics involving the service and supply of construction plant, construction materials and subsequently of materials and supplies normally used by the active air station, are numerous. It may be found necessary to construct access roads to the station, railway connections or sidings to permit the rapid and easy delivery of materials to and within the site.

Some localities may be deficient in certain skilled trades and even in suitable common labor. Nearby communities may not be prepared to house and feed a large transient population. The supply of water during the construction period, power and telephone communications, together with heating facilities, may be of the highest order of importance in getting work under way quickly. The housing of persons in construction quarters and the building of temporary office facilities may involve the expenditure of considerable sums of money.

In addition, it may be necessary to establish dispensary and/or hospital facilities for the care of those who may be injured during construction operations. Temporary intra station roads and public utilities may have to be provided even before any permanent construction can be started.

To overcome these problems careful and intelligent planning on the part of the contractors and Government representatives is highly essential. Warehouse and storage facilities must be made available for the great quantities of materials which are essential for the economical employment of large numbers of men.

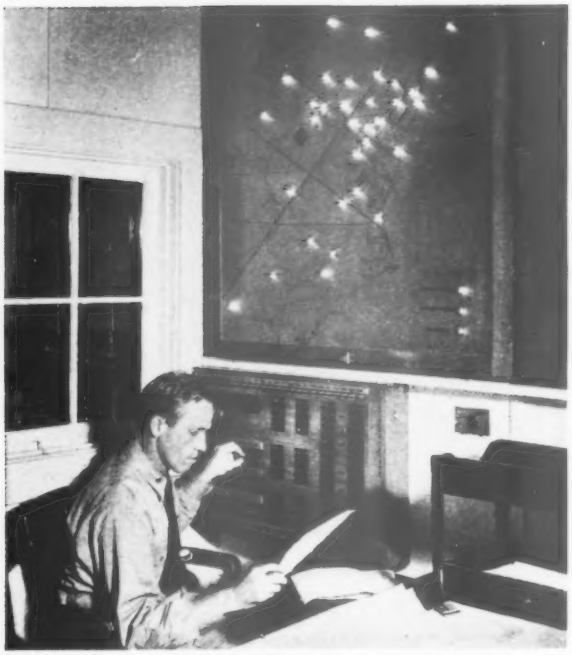
Some idea of the magnitude of the operation may be had when one realizes that the construction of a modern Naval air station probably involves upwards of 12,000,000 man-hours of work per year and the use of as much as $2,000,000 worth of construction equipment of all kinds.

The problems involved in the construction of Naval air stations at outlying islands such as those in the Pacific and in the Atlantic are much greater and more difficult. At these points the progress is dependent entirely upon waterborne transportation and the ability to induce labor to live in these isolated places for the period during which the building operations are underway. This always entails increased financial obligations and special recreational programs and facilities. Due to the shortage of commercial shipping facilities it frequently has been found necessary to charter ships or to rely upon Naval transport. At remote places the maintenance of the health of all persons is of the first order of importance, and constant attention must be devoted to uninterrupted and satisfactory supplies of water and food, and the provision of the ordinary comforts of life. Our pioneer construction men are today rendering very valuable service and their efforts are real contributions to the defense of our country.

One may ask why these Naval air stations are necessary. Consideration of the following will quickly demonstrate their tremendous importance to Naval aviation. Every airborne ship is eventually dependent upon shore based facilities for its maintenance. An airship is self-sustaining only during the time it is in flight. Routine inspection and minor repair work for correction of wear and tear is of the most exacting nature

(*Continued on page* 196)

AEROLOGY



Colored lights designate flight conditions on this area map. Aerologists (below) study chart to prepare forecast.

Naval airmen never make a cross-country flight without first discussing the weather thoroughly with the station aerologist.

by Lieut. Comm.
H. T. ORVILLE

Aerological officer, flight division, Bureau of Aeronautics, Lieutenant Commander Orville holds designation of Naval Aviator (airships). Naval Academy graduate in 1925, he did extensive postgraduate work in aerology at the Academy, M.I.T., Lakehurst and Anacostia Naval air stations. Born in Saratoga, Wyo., now 40, is noted balloonist, twice flew in Gordon Bennett races.

Fleet air action depends on the weather. The Navy maintains a wide-spread organization for studying aerological changes.

PRIOR to the World War in 1914, no nation, with the possible exception of Germany, had foreseen the need for meteorological information in modern warfare. During the war, when the weather repeatedly foiled the efforts of von Scheer to co-ordinate the movements of the High Seas Fleet, and when low visibility frequently interfered with both the British and the German fleets, the belligerent powers were brought to a realization of the urgent necessity for a highly specialized meteorological service in connection with the planning and execution of fleet maneuvers, aircraft operations, zeppelin raids, gas attacks and practically all other forms of modern warfare.

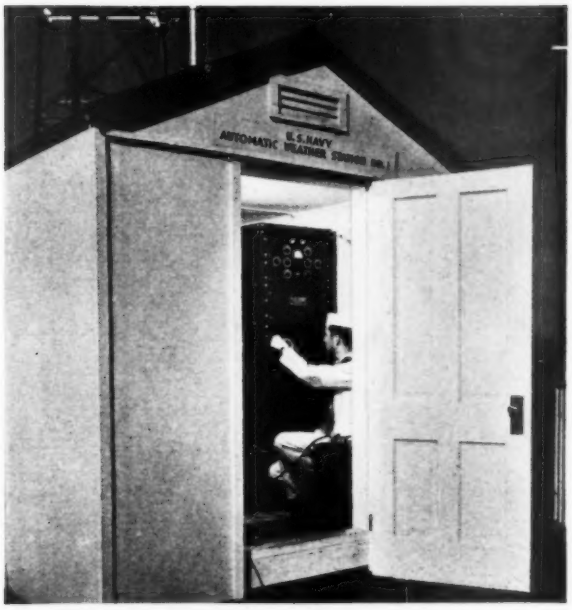
With the entry of the United States into the World War in 1917, there arose, as a result of great expansion and development of highly specialized technique in various forms of warfare, especially aeronautics, gas warfare, and long range gunnery, an urgent need for much more information than had ever before been required by the military and Naval forces.

The existing civilian meteorological services were unprepared to provide the necessary technical meteorological and aerological information and unable to furnish from the forecasting centers the accurate and detailed information required in the immediate theater of operations. The only effective method for meeting the requirements of the fleet and force commanders at the scene of the operations was to provide an organization of trained meteorologists equipped with the necessary instruments.

In 1917, the Navy had no officers with special training in meteorology and no instruments except ship barometers, wet and dry bulb thermometers and mast head anemometers. In response to repeated demands for aerological facilities from the U. S. Naval forces in Europe, the first steps toward establishing a Naval Aerological Organization were taken in December, 1917. When this need was brought to the attention of the Navy Department, Assistant Secretary of the Navy Franklin D. Roosevelt invited his friend, Dr. Alexander McAdie, Director of Blue Hill Observatory, Harvard University, to enroll in the Naval Reserve for the purpose of surveying Naval needs and organizing a wartime Naval Aerological Organization.

Blue Hill Observatory had pioneered in aerological research and had contributed work of great value under its former director, Dr. Rotch. Accordingly, Dr. McAdie was enrolled as a lieutenant commander in the Naval Reserve and was attached to the Naval aviation organization then under the Chief of Naval Operations. It is interesting to note that the letter of January 25, 1918, from the Supervisor, Naval Reserve Flying Corps, to the Bureau of Navigation requesting the enrollment of Dr. McAdie in the Navy as a lieutenant commander was signed by Lieut. J. H. Towers, U.S.N., Acting Supervisor, now Rear Adm. J. H. Towers, U.S.N., Chief of the Bureau of Aeronautics.

Coded teletype messages carry latest weather data to every Naval Air Station, supplementing civil meteorology reports.



Navy now uses automatic radio-operated weather stations to record meteorological data at remote but strategic points.

An officer training program providing an intensive course in meteorology was started at Blue Hill in connection with the aviation ground school at the Massachusetts Institute of Technology, Cambridge, Mass. A similar school for enlisted personnel was organized at Pelham Bay, N. Y. The course in aerology at this school was designed to provide weather observers and assistants to carry out office routine.

The approved recommendations and plans called for providing aerological personnel for all Naval air stations, first in Europe and then in the United States. By the end of the War, 50 officers and approximately 200 men were engaged in Naval aerological work.

By the end of 1919 demobilization had reduced the total number trained for aerological duties to approximately eight officers and 12 enlisted men.

During 1920 and 1921, due to the policy of decentralizing administrative duties of Naval aviation among the various bureaus existing at that time, the Naval Aerological Organization was at its lowest ebb from the standpoint of a unit. Although a post-war training program had been started, the officers received only a short course at the Weather Bureau and the enlisted men a short course at the Naval Air Station, Pensacola, Fla. Unfortunately, no provision had been made whereby this special training would qualify the enlisted men for higher ratings.

The major air stations were provided with aerological facilities after the World War and plans were made for establishing aerological units aboard aircraft carriers and tenders.

The aerological section, functioning as a part of the Bureau of Navigation since 1920, was transferred to the Bureau of Aeronautics when it was organized in 1921. The procurement of aerological equipment which had been under the cognizance of the Naval Observatory was placed under the aerological section.

During the period 1922 to 1925, Naval aerology expanded slowly, concentrating on research, co-operating in the development of a method for obtaining winds aloft at shore stations and from shipboard, and assisting in the establishment of a radio network of aerological stations along the Atlantic seaboard, extending from Long Island to Norfolk and westward to Dayton, O.

Realizing the importance of synoptic information for the fleet, the Naval Aerological Organization encouraged and was instrumental in the establishment of radio weather broadcasts from Arlington and later from San Francisco. These broadcasts consisted of synoptic weather reports from about 40 stations and flying weather forecasts morning and evening for all territory east of the Mississippi.

An extension of this radio broadcast service was soon established for the Pacific Ocean areas, including Guam, Philippines,

Weather-recording instruments usually are on control tower at Naval Air Stations. Anemometers (inset) record speed of wind. Weather information is transmitted to instruments in tower, then is relayed to planes within range of radio.

Small radio sonde balloons carry instruments into stratosphere where they "catch" conditions and transmit data onto ground charts. Left is radio sonde meteorograph.

The water spout is a phenomena peculiar to Naval aviation. On occasions Caribbean pilots have seen as many as 100 at a time.

and Hawaii. By 1924, the officer personnel situation due to the lack of a suitable training program had become serious. Of the 15 officers who had been given a short course in aerology, only two had been identified with that activity since 1918. Recommendations made to the Bureau of Navigation resulted in the establishment of a regular training program consisting of a two-year aerological course, one year to be spent at the postgraduate school at Annapolis, Md., and the second year at the Massachusetts Institute of Technology and Harvard University.

Eight officers were ordered to the class initiating this program, and successive classes, varying in number from two to six, followed until the summer of 1940, when steps were taken to train additional officers and enlisted men to meet the needs of the rapidly expanding aeronautic organization.

Early in 1940 when the 15,000 plane program was authorized, the training program for both the officers and the enlisted aerographers was accelerated in order that aerological facilities could be provided for the additional patrol wings, aircraft carriers, aircraft tenders, Naval air stations, and advanced bases. The importance of getting such a training program under way immediately is emphasized by the fact that at least three years of academic and practical training are necessary before an officer can become a thoroughly qualified aerologist, capable of assuming full responsibilities at major air stations or on board combatant ships.

The decision was made to initiate intensive training for officers. The postgraduate school at Annapolis prepared an intensive course of training in aerological engineering to cover a period of 18 months. This course was designed to give thorough instruction in advanced mathematics and physics, dynamic meteorology, synoptic meteorology, laboratory work, isentropic analysis, frontal and air mass analysis, forecasting and aerological instruments. Eighteen officers were ordered to the first class starting in April, 1941.

In co-operation with the Weather Bureau and the Civil Aeronautics Administration, some 70 odd students were sent to selected civilian universities for an intensive course of training in meteorology. These men were required to be college graduates with a degree in engineering or science and physically qualified to accept a commission in the Army or Naval Reserves. Thirty-six of these students elected to join the Navy and are now undergoing an intensive course of training in Naval aerological routine and forecasting prior to assignment as assistants at major air stations and other Naval aviation activities.

The enlisted men are trained at the aerographer school at the Naval Air Station, Lakehurst, N. J. The primary course covers the more elementary subjects required to train men as weather observers. These men are qualified to make accurate and complete surface and upper air observations. The advanced course includes air mass and frontal analysis, weather forecasting, elements of dynamic meteorology, synoptic weather chart analysis and repair and maintenance of aerological instruments. The students qualify in forecasting and supervisory duties in the aerological office.

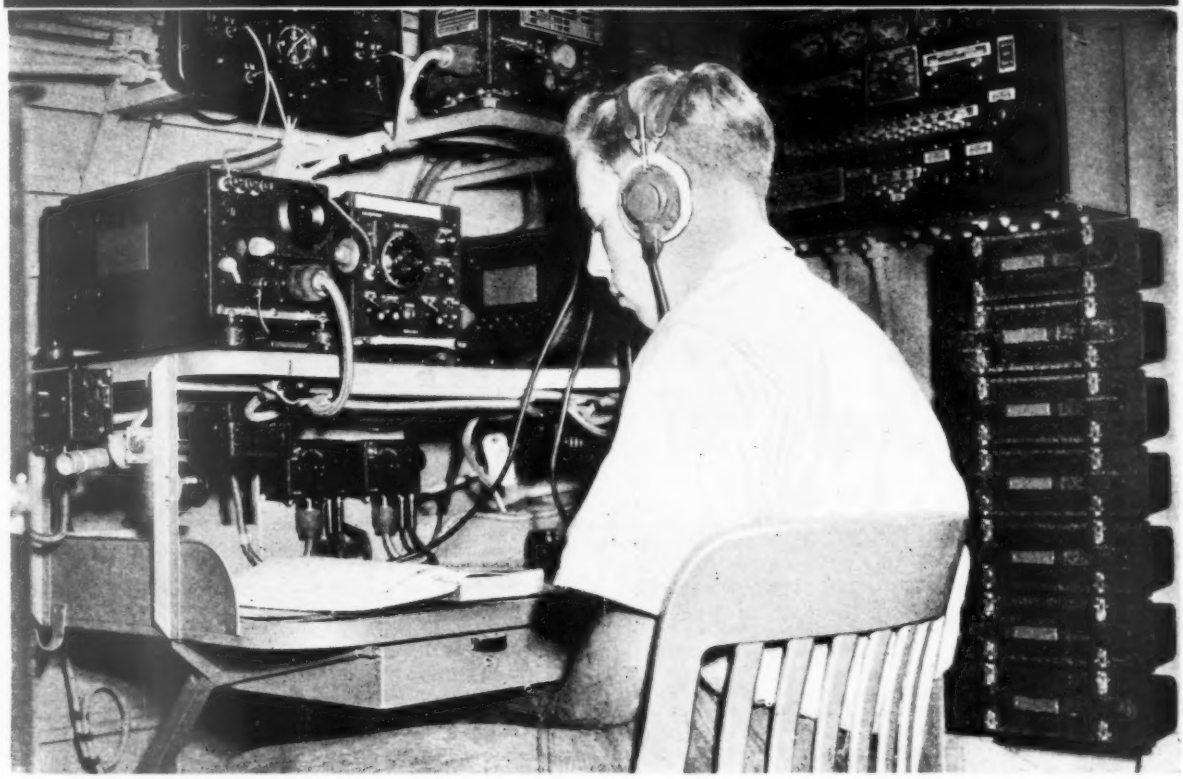
Candidates for the primary school must be at least high school graduates and must have majored in mathematics and physics. In addition to these requirements, they must have attained a high scholastic and practical mark at the recruit school when enlisting in the Navy. By official request, and through a careful process of selection, all men meeting the above requirements are ordered to an aerological office aboard ship or at a Naval air station where they receive several months of preliminary instruction in aerological routine prior to assignment to the aerographer school for a three months intensive training course. This has been shortened, during the present emergency, from the normal peacetime period of six months. Upon successful completion, the students are graduated and receive the rating of third class aerographer and are ordered to duty in the Atlantic, Asiatic or Pacific Fleets or to one of the various Naval air stations now extending from the arctic to the tropics and from China to Newfoundland. The training in aerology, under the supervision of experienced officers and older aerographers, is continued at the new assignments ashore and afloat. Promotion to the next higher rating is made as fast as a man can qualify.

After several years with an aerological unit and when the

(*Continued on page* 170)

RADIO

Naval aircraft carry the most powerful and efficient radio equipment yet to be perfected by engineers.



Radio installation in a modern Navy patrol bomber features duplicate equipment, includes both phone and code apparatus.

by Comm.
G. B. H. HALL

Graduate of the Naval Academy in 1920, Commander Hall returned in 1931 for postgraduate course in communication engineering, now is attached to Bureau of Aeronautics' radio, electrical section. Born in Franklinville, N. Y., January 28, 1900, he was designated a Naval Aviator in 1925, has served as commander of Scouting Squadron 42 and Patrol Wing Five.

THE development of aircraft radio has affected and in turn has been affected by the development of the airplane. Coincident with each improvement in plane characteristics have been the demands for improved radio performance. The meeting of these demands immediately enlarged the usefulness of the airplane. This progressive improvement continues. The search for the best in radio, including direction finding equipment, cannot be relaxed if Naval airplanes are to carry out their prescribed missions in a satisfactory manner.

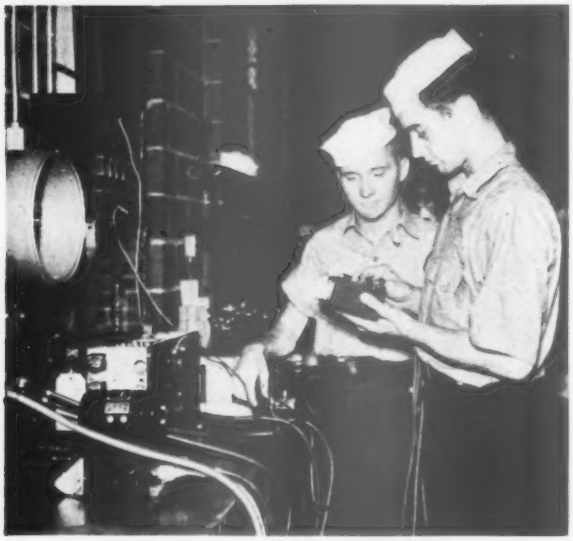
Records indicate that the first radio communication in a Naval aircraft in flight occurred at the Naval Academy on July 26, 1912. This communication, between a Naval seaplane at 300 feet altitude and the *U.S.S. Stringham*, was maintained up to a separation distance of three miles—quite a feat, considering the state of development of both plane and radio at that time.

From year to year since that time, the Navy, by independent research and aided greatly by a number of commercial radio companies, has developed Naval aircraft radio to its present degree of utility. New models of equipment received have been ground-tested at the Naval Research Laboratory and flight-tested from the Naval Air Station, Anacostia, D. C. When successful in these trials, they have been sent to the Fleet. Each model produced has been an improvement over its predecessor since it has incorporated all that could be learned from Fleet use and the parallel advancement in other branches of the radio field.

Year-to-year purchase of advanced models has resulted in various manufacturers maintaining competent radio engineers who have become well-versed in many of the particular problems of Naval aircraft. The Navy has co-operated closely with civil aeronautics and with other services in establishing sources of supply of similar sets, bearing in mind at all times the basic necessity of service with the U. S. Fleet. By this process of development, the U. S. Navy has been able to evolve standard models of radio equipment which may be procured in sufficient quantities to meet the expanded demands of Naval aviation.

Several of the functions of aircraft radio which may be enumerated are:

a. Communications in connection with scouting and search operations.
b. Navigation and direction finding.
c. Observation and spotting of gunfire.



Vital to the Fleet's missions are its aircraft radiomen. At Pensacola these trainees study control box and transmitter.

Radio repairmen must know every part of the instruments they work with. These experts dismantle and check receiving sets.

d. Instrument landings.
e. Communication within aircraft.

A partial list of the fundamentals confronting a radio engineer in design of Naval aircraft radio equipment includes:

Reliability—the radio must function, within narrow limits of frequency, under all conditions of temperature and humidity, and at all altitudes to which planes are capable of flying.

Flexibility—the radio must be capable of operation with many different types of ships, shore stations and other aircraft.

Power—(a) sufficient power must be fed into the radiating system; (b) input power is limited to that with which the various planes are equipped.

Weight—must be reduced to a minimum.

Form Factor—must fit in limited space(s).

Simplicity of Use—the radio must be easily operated without sacrifice of performance.

At all large Naval Air Stations are radio-equipped control towers. Unit below was installed at Floyd Bennett air base.

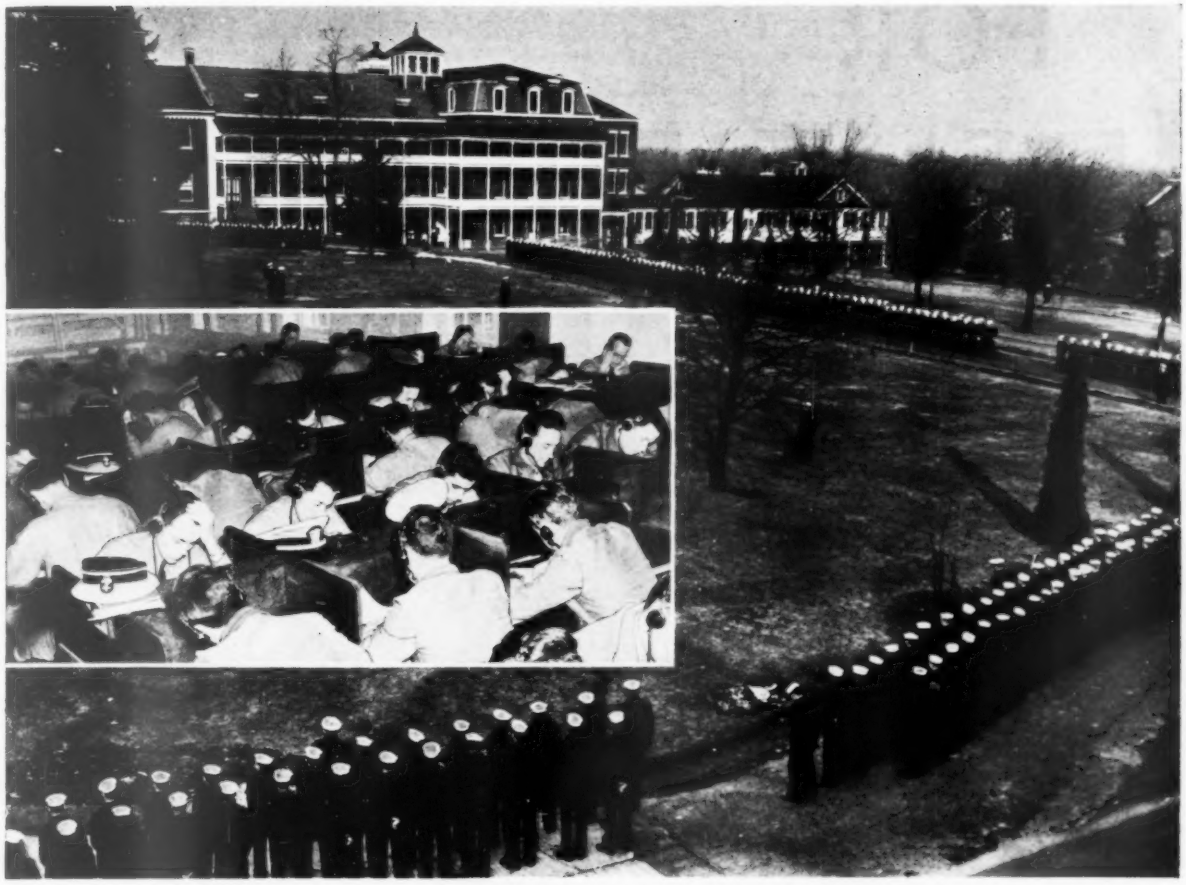
Some of the other considerations which must be taken into account in design and installation of aircraft radio are:

Icing of aerials.
Fire, shock and lightning hazards.
Noise elimination—both acoustical and electrical, under all conditions of flight and vibration.
Convenience in operation—fatigue factor of pilots and operators.
Control—both local and remote.
Break-in features.
Corrosion prevention.

Obviously, there are many difficulties attending an endeavor to fit a radio which is in the experimental stage to an airplane which is also under initial procurement and test. The Bureau of Aeronautics' specifications for the new airplane include lists of the various radio components, models of which are furnished the airplane manufacturer. Second, a Bureau of Aeronautics radio representative, in conjunction with representatives of certain other sections, assists in "mocking up" a wooden model for the original experimental airplane. Third, the experimental airplane, when delivered to the Naval Air Station, Anacostia, or other testing centers, is thoroughly inspected and flight-tested for all faults. Fourth, the first production model is checked and tested to insure that all previously discovered faults have been eliminated and that new ones have not developed. With a view toward eliminating undue correspondence and preventing unnecessary corrections, the Bureau has recently furnished all contractors with a list of the common faults found in a number of new airplanes.

Shortage of trained personnel has in the past prevented the permanent assignment of Naval radiomen to the staffs of inspectors of Naval aircraft for the correction of errors at the earliest possible time. The Navy's expansion program, however, has now progressed to the extent that a number of reserve officers are being trained for the dual purpose of assisting the contractor in early eradication of errors and for the inspection and test of production installations before flyaway. The policy of installing radio equipment at the manufacturer's plant was initiated recently in order to remove this load from the shoulders of operating Fleet personnel.

The procurement of Naval radio equipment is under the joint cognizance of the Bureau of Aeronautics and the Bureau of Ships and is determined by the features set up by the Chief of Naval Operations. The specifications of the equipment are drafted by the Bureau of Ships, which has on duty post-graduate radio engineers (Naval aviators). The characteristics and performance of the equipment must be satisfactory to the Bureau of Aeronautics, which obtains the necessary funds and initiates the placement of orders for the various amounts. This system, designed to keep the Naval aeronautical



The day begins for students at U. S. Naval Reserve Radio School, Noroton Heights, Conn., with parade for colors and formation drills above. Flight students (insert) must learn to send and receive code.

radio closely allied with that of the shipboard equipment with which it must operate, at the same time keeps the ship radio engineers acquainted with the specific problems with which aircraft radio operators, whether pilots or otherwise, are confronted.

Procurement of the power supply, which must meet many other electrical demands of the airplane and its numerous components such as headsets, microphones, power wiring, antenna, headset cords, etc., is a direct function of the Bureau of Aeronautics. A few of the features of electrical power supply with which radio equipment is closely concerned are:

Voltage (AC or DC).
Frequency (if AC).
Voltage regulation.
Battery (if DC).
Wave shape (if AC).
Conductors and connector plugs.

The maintenance of Naval aircraft radio until recent years was left largely to Fleet and individual shore units. Several years ago the Naval aircraft factory and the Naval Air Station, San Diego, commenced overhauling equipment on a rather large scale, and the recent expansion of Naval aviation has required the establishment of a number of aircraft radio overhaul shops at other main air bases. These shops are designed to care for all aircraft radio overhaul requirements.

Inspection is an important feature in insuring the receipt of workable aircraft radio. The finished product is inspected at the radio manufacturer's plant by the inspector of Naval material before shipping to the Naval aircraft factory and other storage places for final acceptance, storage and distribution to the various aircraft manufacturing plants for installation, and to the various Fleet posts.

In the early days of Naval aviation, aircraft radio operators were nearly all initially trained aboard ship in procedure, operating and material upkeep prior to being detailed to a squadron—a satisfactory method when the Naval aviation service was small. With increased hours in flying and the demands of gunnery, the general expanded use of aircraft, however, has required the evolution of a special designation of "qualair" to those men possessing aircraft radio qualifications in order that future change of duty orders would not remove these specially trained men from aircraft contact over a long period of time.

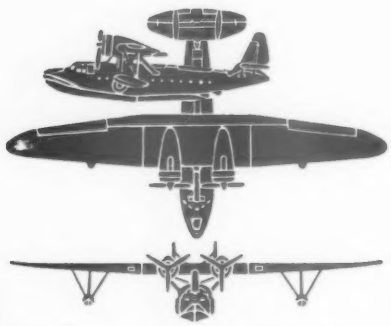
As a result of the present Naval expansion, schools for training a large number of recruits in aircraft radio have been set up at the Naval Air Stations at Jacksonville, San Diego, Alameda, and Seattle. Aeronautical radio equipment of the types used in Fleet aircraft is employed in these schools for instruction purposes. All graduates of these schools will receive the corrected designation "qualair," after reporting to the operating squadrons and upon satisfactory completion of indoctrination training.

Prior to 1939, a number of Naval aircraft radiomen, upon completion of their enlistment or enlistments, accepted employment with C. A. A., commercial aircraft firms, and other Government agencies which recognized the value of their Naval aeronautical training. The writer has, in several instances, been greeted at inland airports by old shipmates or squadron mates who were handling aircraft control towers, material upkeep work and other positions requiring technical training. A number of aircraft radiomen in the service have been sent to the Naval Air Station at Pensacola and become Naval aviation pilots. The combination of the two ratings is particularly valuable.

Until recently, all Naval aircraft radiomen, before obtaining a chief petty officer rating, were required to graduate from the Radio Material School at the Naval Research Laboratory,

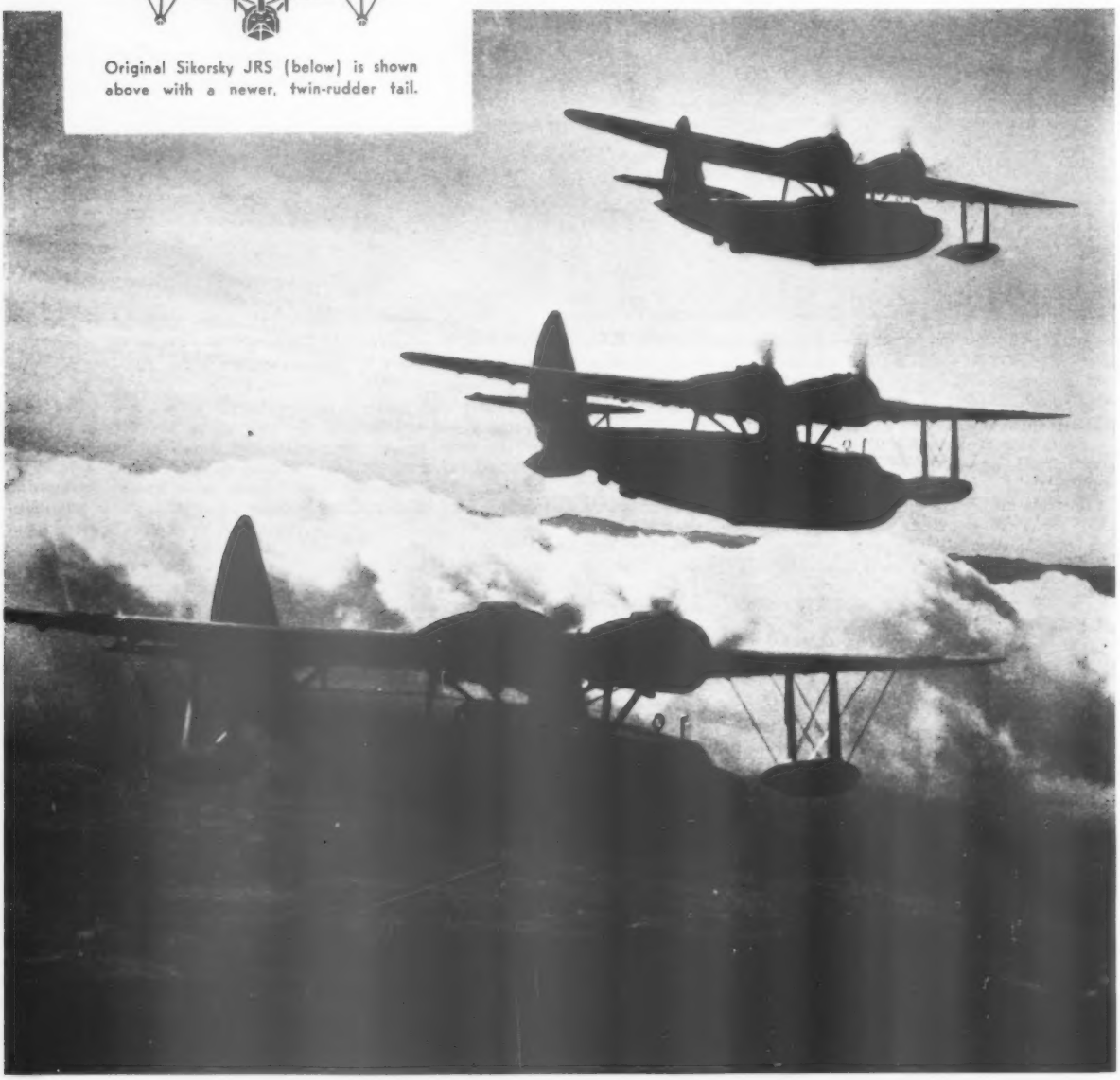
(*Continued on page* 178)

FOR IDENTIFICATION



Original Sikorsky JRS (below) is shown above with a newer, twin-rudder tail.

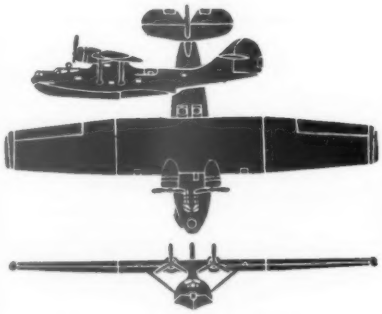
By special arrangement with the Navy Department, the silhouettes of contemporary Naval aircraft are published on the following pages as an exclusive feature of this issue.



Vitally important to the nation's civil defense is the ability of the general public, and aircraft warning service observers in particular, to identify readily Naval and military aircraft types. To aid in this important work, we present herewith easily identifiable silhouettes of current Navy aircraft.

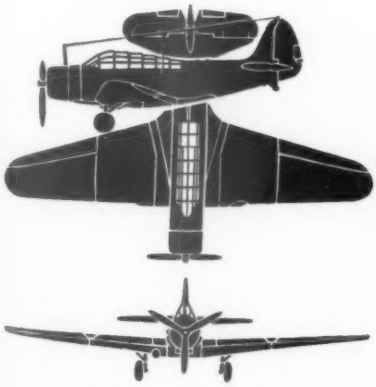
PATROL BOMBERS

Martin "Mariner" (PBM).



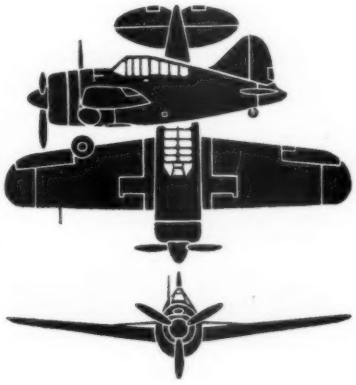
Consolidated "Catalina" (PBY).

TORPEDO BOMBER



Douglas "Devastator" (TBD).

FIGHTERS

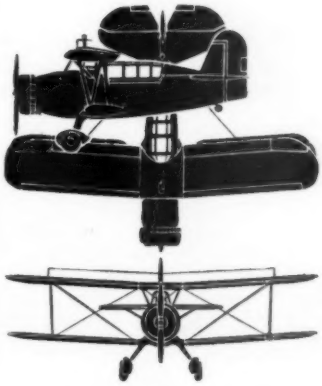


Brewster "Buffalo" (F2A).

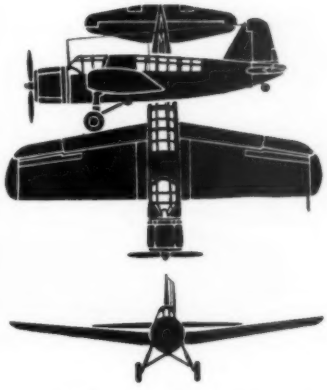
Grumman (F3F).

Grumman "Wildcat" (F4F).

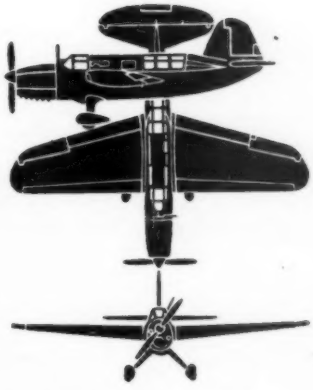
SCOUTING and OBSERVATION



Curtiss SOC (Navy SON).

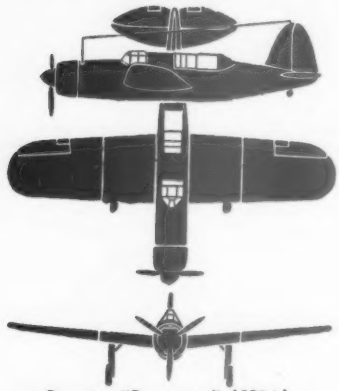


Vought-Sikorsky "Kingfisher" (OS2U).

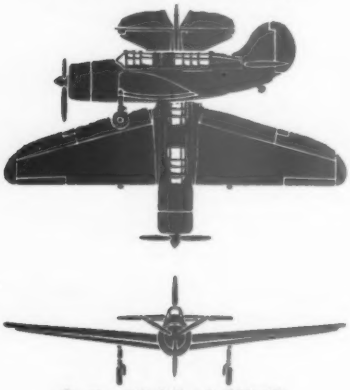


Curtiss "Seagull" (SO3C).

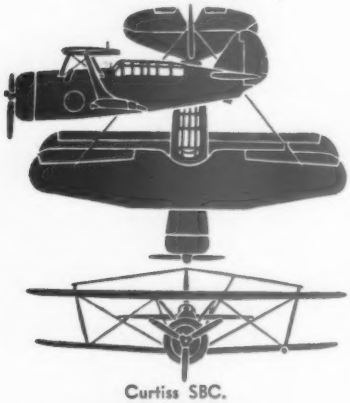
SCOUT BOMBERS



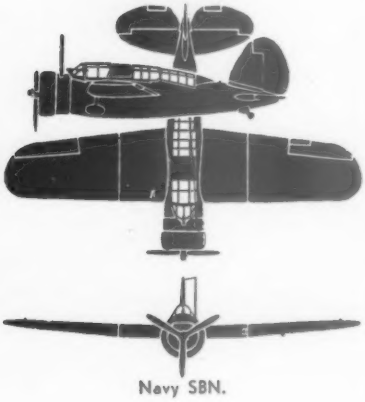
Brewster "Buccaneer" (SB2A).



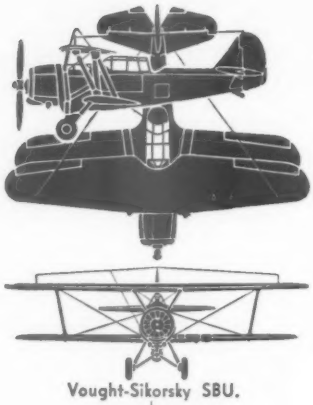
Curtiss "Helldiver" (SB2C).



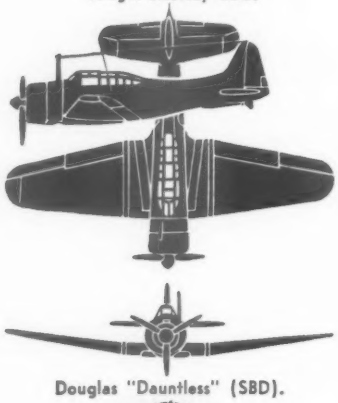
Curtiss SBC.



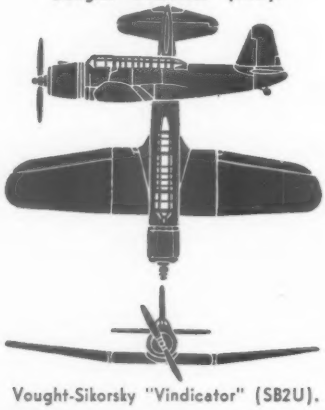
Navy SBN.



Vought-Sikorsky SBU.

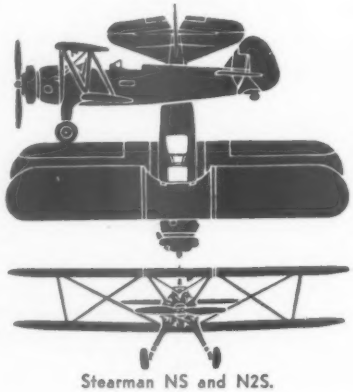


Douglas "Dauntless" (SBD).

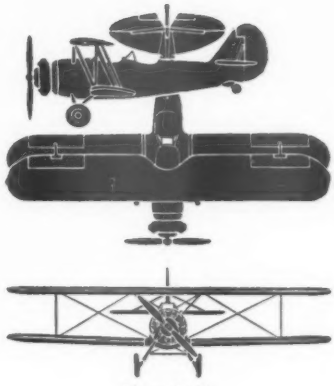


Vought-Sikorsky "Vindicator" (SB2U).

TRAINERS

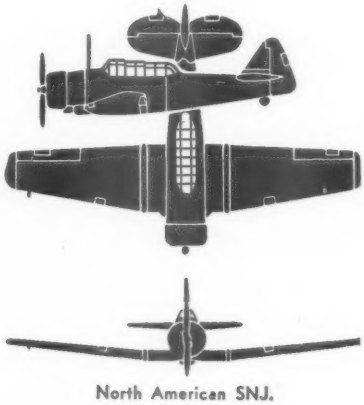


Stearman NS and N2S.

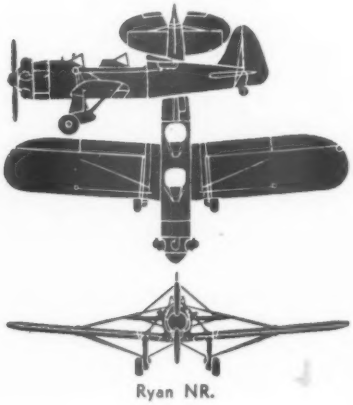


Navy N3N.

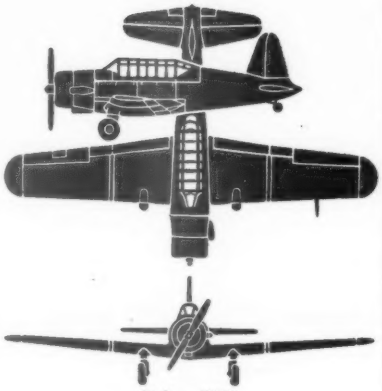
Curtiss SNC.



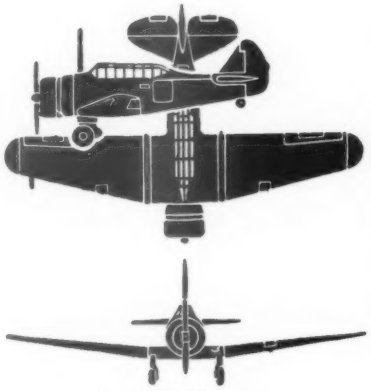
North American SNJ.



Ryan NR.

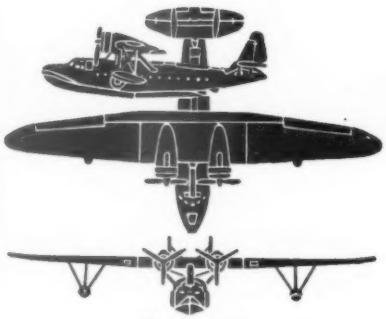


Vultee SNV.

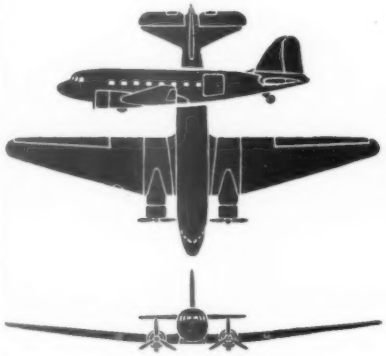


North American NJ.

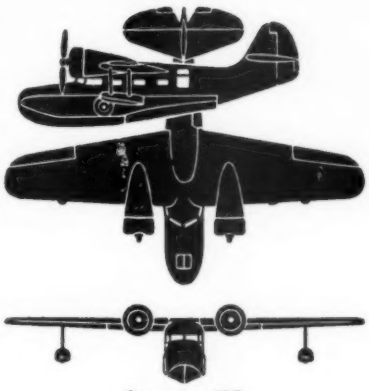
UTILITY and TRANSPORT



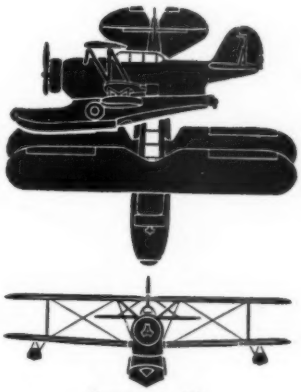
Sikorsky JRS.



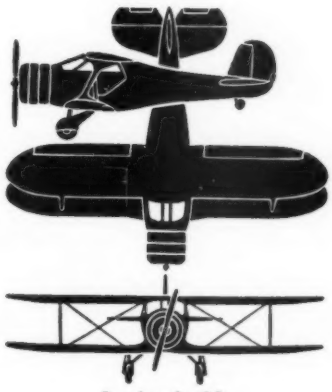
Douglas R4D.



Grumman JRF.



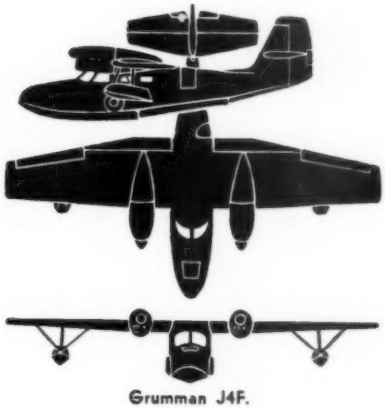
Grumman J2F.



Beechcraft GB.

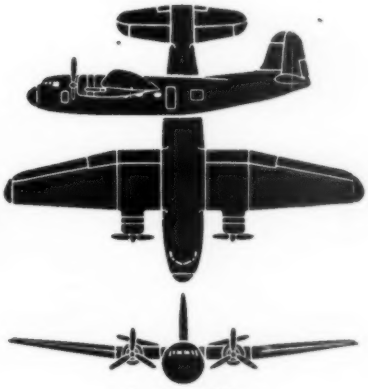
Lockheed R50.

Beechcraft JRB.



Grumman J4F.

Lockheed R2O.



Douglas R3D.

CV—The Carrier

(*Continued from page* 120)

craft carrier work would be impossible. When the mission is completed, the planes return to the carrier. With the same precision with which they took off, the planes, at signal, break formation and prepare to land.

This operation involves precision flying at low speeds and at low altitudes: In order to make a good approach and landing, the pilot must be skillful, smooth, and steady. To insure this skill and smoothness the pilot must know his plane, must have total control of it at all times and must be in a state of relaxed concentration to insure smooth, prompt reaction.

The performance of carrier planes may be somewhat lowered because of many considerations of design incident to carrier operations. In order to allow use of large numbers of planes, their size must be limited. To withstand the shock of an arrested landing, a special system used on our carriers, the plane structures must be strengthened. To insure possible landing in the restricted area and to preclude violent arrestation, the landing speed must be lowered. To allow short take-off runs and large bomb loads, weight must be limited and power boosted.

In addition to these considerations, the carrier planes suffer further compromise in design in order that flexibility of operation may be insured by utilizing all types of planes for various missions.

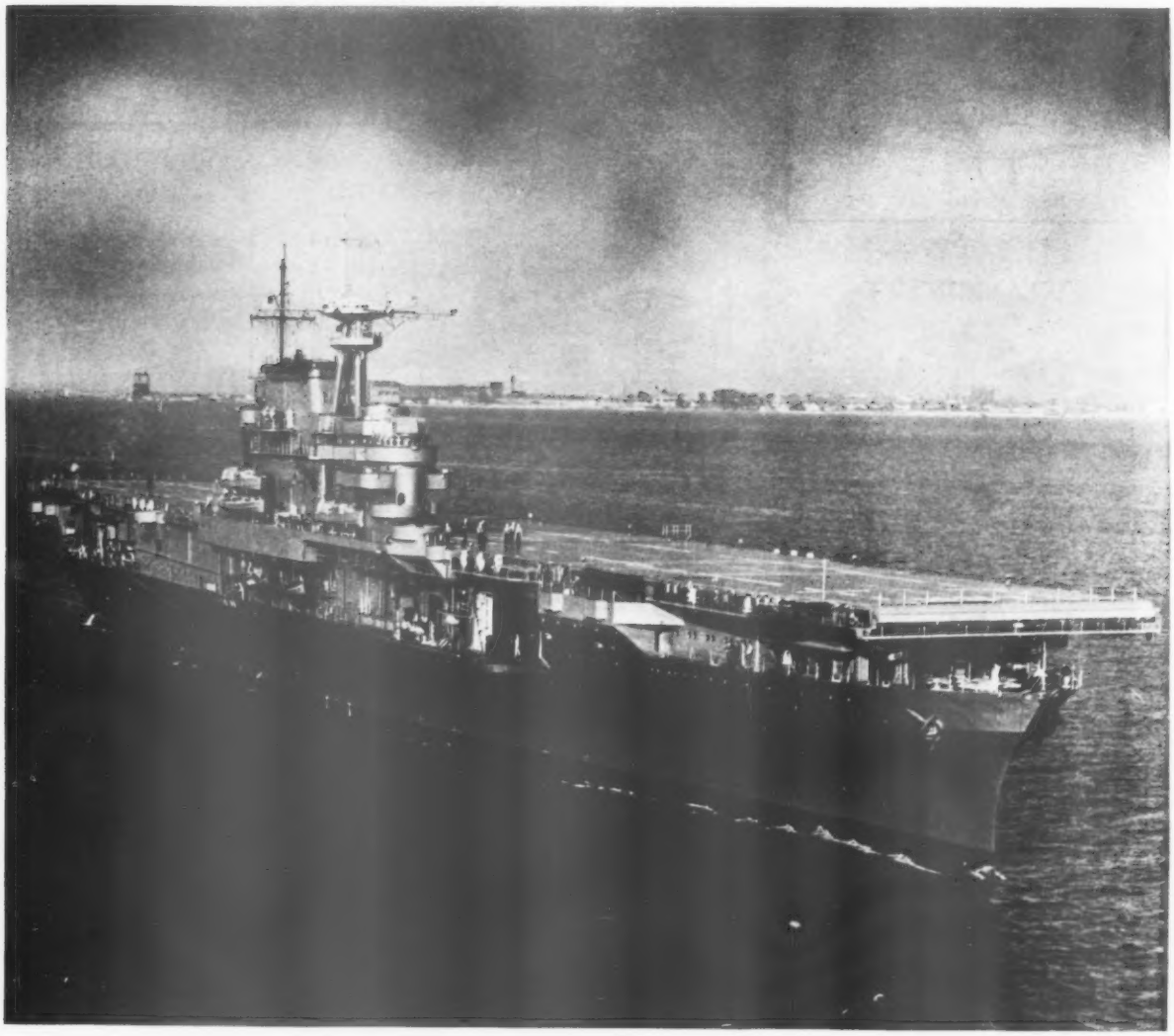
Our present carriers employ an air group normally composed of fighters, scouts, bomber and torpedo planes. Each is best adapted to its primary mission but, in addition, is well adapted to each other's tasks when the situation demands it. Thus a scout may be employed as a heavy bomber, the fighter may become a scout, or all planes may be employed as a single attacking force or a single search force, etc.

With our present number of carriers, this flexible composition and the present number of planes making up the group provide the maximum possible air aid to the Fleet.

Further developments will dictate necessary change. The carriers will always be adaptable to change and improvement.

END

Commissioned October 20, 1941, U.S.S. Hornet (CV8) is Navy's newest carrier. Similar to Yorktown and Enterprise, the Hornet's normal complement of planes is 75 (four tactical squadrons plus three utility types). Identification letters on flight deck are HRNT. Hornet is sixth Navy vessel of that name.



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showing all the Piper planes will be sent you on request or may be obtained from your Piper Dealer. Or, if you wish a copy of the new Piper deluxe, full-color, 16-page catalog, it will be gladly mailed you, providing you enclose 10c in stamps or coin for postage-handling. Piper Aircraft Corporation, Department PA12, Lock Haven, Penna., U.S.A.

FREE FLYING COURSE in his own plane is offered the purchaser of a new Piper. It consists of eight hours of dual flight instruction under a government-licensed instructor . . . take-offs, landings, taxiing and fundamental air maneuvers. At the completion of this free course the average person is ready to solo. Ask the Piper Dealer about the free flying course and for a free Piper plane flight demonstration.

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Procurement

(*Continued from page* 142)

service. Each service was to supervise all plant expansion under its cognizance. Likewise, where both services obtain the same model airplane, engine or propeller in one plant, the primary service was to purchase for both. In case of contracts for airplanes or material peculiar to one service, however, that service was privileged to negotiate and place its own contracts subject to previous allotment of the necessary capacity according to the Office of Production Management schedules.

Later it was also agreed that the cognizant service in general would conduct the inspection of all material for both services. This agreement has been closely adhered to and, so far, has operated in a very successful manner with a minimum amount of duplication of effort. As the program has been expanded by the Army or the Navy the additional orders have been placed, step by step, in a similar manner.

A Typical Airplane Contract

Assuming that an order of planes of a certain model, the contractor who is to build them and delivery dates desired have all been determined, we will follow the principal steps in the procurement of the airplanes, together with all the equipment which goes into them.

Prior to determining this order, the availability of plant capacity has been considered. If additional facilities are necessary the Production Branch and the Plant Facilities Section under the Procurement Officer will be the first to take action, but for purposes of simplicity we will return to this phase of the matter later on.

In normal times, airplane contracts are usually let as the result of competition in one form or another and they are almost invariably fixed price contracts. Under present conditions, however, the prospective builder of a certain order is more or less predetermined by circumstances as already explained. As a result, practically all airplane, engine, propeller, accessory and equipment contracts are negotiated as to price or cost. With growing labor uncertainties, fixed price contracts are being almost entirely replaced by cost-plus fixed fee contracts.

Contract Procedure

As soon as the Procurement Officer receives sufficient information as to the number, deliveries and specifications of airplanes, engines and propellers to be purchased, he enters into preliminary negotiations with the prospective builder.

To expedite work, however, a contractor is usually issued a "letter of intent" which allows him to go ahead immediately with legal coverage for any work done or material purchased in advance of actual award of contract.

In preliminary negotiations the contractor is furnished the specifications, all other pertinent data, and is requested to submit a letter with proposed deliveries and a complete breakdown and substantiation of costs to be allowed. When costs are thoroughly analyzed by the Costs and Changes Section and terms for a contract are finally agreed upon, the information is sent to the Requisition Section. After the requisition is prepared and approved by the Chief of Bureau, it is sent to the Procurement Legal Division in the Under Secretary's office together with a letter requesting authority to make a negotiated contract. Upon approval, the requisition and letter go to the Bureau of Supplies and Accounts for the purpose of obtaining a formal proposal from the contractor. The proposal is returned to the Contract Section of the Bureau of Aeronautics to check conformance with the agreement to make recommendations of award. It is then returned to the Bureau of Supplies and Accounts for award of contract.

Scheduling and Progress

In the meantime, the Schedule and Progress Section of the Production Branch has prepared a monthly schedule of required airplane deliveries and a complete list of all "Government furnished equipment" to be furnished the airplane and engine contractors.

The required deliveries of each item of "Government furnished equipment" are scheduled month by month. These are grouped with schedules for similar material for other airplane orders. The total number of each item to be ordered is determined after correlating information from the Maintenance Division, since the spares and parts required for operational repairs and periodic overhaul over a number of years must be purchased as nearly as they can be determined along with the original order.

The quantity required and delivery dates desired for each item are then given to the Procurement Branch for purchasing. After contracts are let, the Schedule and Progress Section follows up the delivery schedule of each item from sub-sub-contractor to sub-contractor to prime contractor to delivery of the completed airplanes and further to endeavor to meet shortages, readjust schedules, etc., as necessary.

In case of material shortages or machine tools shortages of prime contractors or sub-contractors, the Priorities Section comes into action, or rather we should say that under present conditions it is in continual action. Contacts with the Army-Navy Munitions Board priorities committee, the various machine tool committees, the Scheduling Unit, the Office of Production Management and other agencies are multitudinous in connection with administration of the priorities system for effective allocation of materials and tools in the defense program.

Miscellaneous Contracts

The steps leading up to contracts for a considerable share of "Government furnished equipment" and other material and supplies such as steel, aluminum and aluminum alloys, fabric, paint, nuts and bolts, gasoline, oil and spark plugs are handled in a similar but more routine manner. The requirements for these items comes largely from the Bureau's Maintenance Division. The specifications are usually in standard form.

Contract Section—Cost and Changes Section

After a contract is let, the contract sec-

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tion keeps records of all matters in connection with performance of the contract until final completion and payment. The many changes in contracts make up a considerable portion of the work of the Contract Section and also of the Costs and Changes Section. Changes may be originated by the Plans Division, or the Engineering Branch of the Bureau of Aeronautics, or by the contractor. The Costs and Changes Section checks the contractor's estimate or recommends revision. After final approval by the Plans Division, the Contract Section records pertinent data and processes the changes to the Bureau of Supplies and Accounts.

The Costs and Changes Section also prepares for the Plans Division all estimates of the unit costs of proposed airplane programs.

The Contract Section maintains lists of acceptable bidders and manufacturers for all manner of specialized aviation material. This information is forwarded to the Bureau of Supplies and Accounts with the requisitions for all such material. The Bureau of Supplies and Accounts maintains the lists for all standard Navy material. The requirements for the acceptable list vary according to the article. In the case of the airplane list, for instance, a complete exposition of the management, financial backing, engineering staff and plant facilities is required. For most of the accessories and equipment, such as spark plugs, the passing of certain tests either at the Naval aircraft factory at Philadelphia or Wright Field at Dayton, O., is required.

The Contract Section also issues Project Orders, which are orders on Government plants, such as the Naval aircraft factory, for the manufacture of certain articles and special equipment. Otherwise, such orders originate and are handled similarly to contracts.

Inspection

The Navy's interests at the various contractors' plants are represented by inspectors of Naval aircraft. Three inspection districts have been established; eastern, central and western, with a general inspector in charge of each district. The general inspectors exercise general supervision over the inspectors at each plant in his district in matters of policy and personnel and take care of special situations.

Before the present expansion, quality and workmanship in the contractors' plants received normally 100 per cent inspection. Under present conditions, however, there have been two radical changes in the inspection set-up: (1) Because of the large volume of work and the lack of a sufficient number of experienced personnel, detailed inspection by the Government inspectors has been largely eliminated and "spot" inspection is employed as a check on the contractor's inspection system. (2) Priority certifications, approval of partial payment invoices, check and co-ordination of plant facility contracts, plant protection and intelligence work have been added to the inspector's duties.

A demonstration of each experimental airplane and the first article of each production order is witnessed by the inspector in order to determine if it will meet the guarantees prior to delivery for trials. Airplanes of a contract are checked individually before delivery in compliance with contract stipulations and specifications. The inspector flies many or all of them as a final check.

A central inspection office is maintained in the Production Branch to administer matters of policy and personnel in the various inspection offices.

Plant Facilities

This section was organized about a year ago to handle the many financial, legal and contractual matters in connection with additional plant facilities financed by the Government for Navy-sponsored plants.

To carry out this work, a legal, financial and machine tool staff is required. At the present time there are approximately 20 prime contractors and 40 sub-contractors having plant facility contracts.

In general, these facilities have been financed by one of two methods—(a) By a direct Emergency Plant Facility contract which provides for the prime contractor: (1) to hire an architect to prepare specifications and select a builder by competitive bidding where a building is required; (2) to purchase the land if not already owned and (3) to order the necessary tools and equipment—all of these with his own funds. The contractor is repaid by the Bureau of Aeronautics in monthly installments over a period of five years after the facilities are completed—or (b) By a Defense Plant Corporation contract which provides that the contractor shall take practically the same steps as above, but the Defense Plant Corporation, a subsidiary of the Reconstruction Finance Corporation, advances the necessary funds at a moderate interest rate, being repaid later by the Bureau of Aeronautics.

In EPF contracts the title to the buildings and tools is in the name of the contractor, but reverts to the Government when the latter has paid up. In case of termination of the emergency or stoppage of work, the contractor has the option to buy the plant at certain established depreciation rates against the Government's unpaid balance, or to turn the facilities over to the Government and receive full payment.

In DPC contracts the title to the buildings and tools is in the name of the Defense Plant Corporation until repaid by the Navy, but at the end of the emergency, or on stoppage of work, the contractor has the option to take over the facilities at certain established depreciation rates, or let them lapse to the Government.

The investigations leading to these contracts involve far more work than the preparation of the contracts themselves. The contractor must show a complete justification of the expansion desired or necessary in terms of a work load study and a detail list of the facilities required. This must be studied and passed on, or possibly re-negotiated. The Bureau's recommendations must then be cleared through the Judge Advocate General's Office, the Bureau of Supplies and Accounts, and the Office of Production Management. The latter clears the contract for such matters as plant site, sub-contracting and machine tools. In case of DPC contracts, the Defense Plant Corporation must be included in the negotiations.

After the facilities are constructed, there then devolves upon the Plant Facilities Section the responsibility of co-ordinating the inspection and acceptance of the facilities and later their maintenance by the Bureau of Yards and Docks (for buildings), the Inspector of Naval Aircraft (for machine tools), and the Bureau of Supplies and Accounts (for audit of expenditures).

Production Engineering

This section is being organized to take care of the following:

a. Analysis of man-hour, floor area, and machine tool problems.

b. Study, analysis and recommendation as to production methods, shop equipment, shop processes, etc., in various contractors' plants with a view to interchanging information as to advanced methods, encouraging standardization, etc.

c. Study and adaptation of design to facilitate production.

d. Review and control of changes affecting airplanes in production to minimize delays by introducing unavoidable changes at the most favorable point in a production line or a production series.

e. Study and recommendation to obtain maximum interchangeability of parts, accessories and equipment between airplanes of the same manufacture.

Bureau of Supplies and Accounts

As far as procurement is concerned, this article has been confined to those phases performed by the Bureau of Aeronautics.

The Bureau of Supplies and Accounts is the Navy Department's official purchasing agency for all materials except public works, ship and certain ordnance items. The Bureau of Aeronautics, as already indicated, does the negotiating for such special aviation materials as airplanes, engines, propellers, accessories and equipment, the formal steps being handled by established Supplies and Accounts machinery.

In case of standard or commercial aviation materials, the original requisition is sent to the Bureau of Supplies and Accounts which takes all further necessary steps in procurement unless the proposals received from contractors are qualified as to Bureau of Aeronautics specifications or exceed the estimated cost, in which case they are referred to the latter Bureau for recommendation.

The details of the Navy's procedure in connection with production and procurement of material may sound involved and cumbersome to the average layman. However, the method works efficiently and economically. The taxpayers' money allocated to the building up of Naval aviation is, through the methods described, being used for exactly that and no other purpose.

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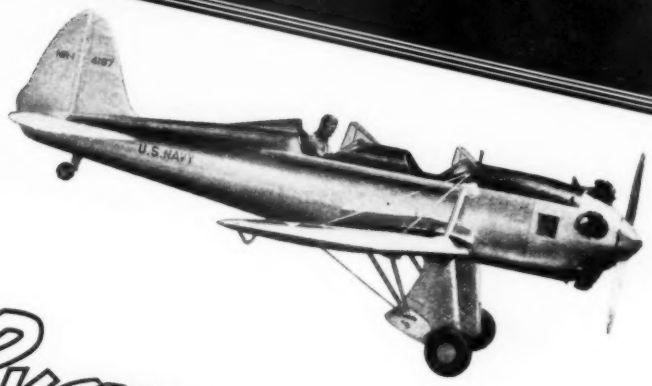

Ryanews Flash

Training superiority: No other primary trainer is so maneuverable as the Ryan; aerodynamically it is tops. For equal flying time, students trained in Ryans show superior piloting skill. Cross-winds are no problem and ground handling is so good, training can continue in stiff winds which ground other types.

Minimum operating cost: Ryan trainers use 1/3 less gas and oil than similar types. Extreme ruggedness of construction and complete interchangeability keep costs at a minimum.

Maintenance man's ideal: Because suggestions of maintenance experts, based on years of experience with Ryan Trainers are incorporated into design, the Ryan is the answer to the maintenance man's prayer.

Repairs at minimum: Because ground-looping is practically unknown with a Ryan, repairs from this cause are almost nil. When they do occur, ground loops do not damage wing structure. And there is no recurring cost of frequent recovering.

Maximum safety: Ryan metal construction is safest possible, offering maximum protection to student and instructor.

They can take it! Ryan Trainers are daily proving their ruggedness in the services of the U.S. Army Air Corps, U.S. Navy and friendly foreign governments.

RYAN AERONAUTICAL CO., Lindbergh Field, San Diego, California

A line-up of Ryan NR-1 Primary Trainers at the U. S. Naval Air Station, Jacksonville, Florida. Official U. S. Navy Photograph.

Aerology

(*Continued from page 156*)

aerographer has advanced to a petty officer first class, he is ordered to the aerographer school for the advanced course. Upon completion of instruction covering a period of 12 weeks (formerly, 20 weeks) he is ordered to supervisory duty with a Naval aviation activity and, after completing three years as a petty officer first class, he is advanced to chief petty officer, the highest non-commissioned rate attainable. Outstanding chief petty officers have a chance to continue their careers in aerology by qualifying for a commission in the Naval Reserve or accepting a lucrative position in civilian life. The valuable training and experience gained in the Service is well substantiated by the fact that several ex-Navy aerographers are now occupying responsible or executive positions with the commercial airlines.

The present organization consists of 45 officers of the regular Navy and 45 officers of the Naval Reserve enrolled from the U. S. Weather Bureau, civilian universities, and commercial airlines, making a total of 90 aerological officers in the aeronautic organization. There are 27 officers under training.

The enlisted men have increased from 150 in 1940 to more than 500 in training or actively engaged in aerological work with the various units of the Fleets or at Naval air stations and advanced bases.

At the present time there are 68 aerological units in the Fleet, distributed as follows: flagships, nine; aircraft carriers, seven; other ships including aircraft tenders, 43; patrol wings, nine. In addition, there are within the shore establishment: Naval air stations, 67; advanced aviation bases, 15; Marine aviation, 6.

From what has been outlined above, it is evident that the function of Naval aerology is to furnish detailed weather information of surface and upper air conditions over land or sea. This is essential to the preparation and execution of operating plans in time of peace and in making strategical and tactical dispositions in time of war.

In accomplishing these duties the various aerological units, at air stations and with our Fleets (Atlantic, Pacific, and Asiatic) perform the following routine work interspersed with additional duties, depending on the operations to be carried out:

1. Prepare weather maps every six hours throughout the day based on weather reports received by teletype or by radio from several hundred stations in the United States, Canada, Alaska, Pacific Islands, Mexico, Central and South America, West Indies, and also from such reports as are available from Naval and merchant ships in the Atlantic and Pacific oceans. These reports are made available to the Navy by the U. S. Weather Bureau through an extensive network of teletype communication systems through the United States and its possessions, and by Naval radio stations at Annapolis, San Francisco, Balboa, Pearl Harbor and Cavite, P.I.

2. Prepare auxiliary charts and diagrams based on upper air soundings made four times daily at selected land stations through the northern hemisphere and supplemented by observations from ships at sea. In addition to the importance for forecasting, these data are used by aircraft for bombing, scouting, aerial navigation and by ships for gunnery practices. A knowledge of winds aloft, of air temperatures, and of relative humidities of the various layers of air extending to 40,000 feet is of great importance for aircraft operations and also for surface and antiaircraft firing since a projectile in flight, as well as an airplane, is materially affected by the atmospheric conditions.

3. Again, at a network of 50 or more selected stations, radio sonde observations taken at altitudes reaching at times, to 70,000 feet to determine the air temperature, relative humidity and other dependent weather elements, are used in forecasting thunderstorms; cloud base and top; visibility, surface and aloft; icing conditions; and related phenomena.

4. Continuous observations of changing weather conditions are made by enlisted aerographers and recorded in aerological records which are probably the most complete and detailed records in existence.

5. From all of the above data, with a high degree of co-ordination, this information is analyzed in the preparation of detailed daily forecasts for all types of aircraft operations including long range patrol flights for distances of 2,000 miles or more and for almost every imaginable type of surface vessel operation. To illustrate, the forecast that the aerologist may be required to issue must include several of a combination of various conditions—surface visibility for ships and aircraft; vertical and oblique visibility for aircraft in flight; force and direction of the wind, surface and aloft, to expected flight altitudes; base and top of clouds; duration, extent, intensity, and type of rain, snow, sleet, or any other form of precipitation; air temperature, surface and aloft, at various flight altitudes; icing conditions, type and altitudes where it may be encountered; expected sea and swell conditions for launching and recovery of aircraft, for landing force operations, for launching and recovery of torpedoes, for fueling destroyers or smaller type ships at sea and for sighting of submarines.

Most Naval air stations are located on, or have connecting lines to, teletype circuits so that hourly weather reports along the commercial airways enable the aerological personnel to keep close watch on the changing weather conditions. Thus advantage may be taken of every hour of favorable flying weather. This also permits the issuance of timely warnings of sudden squalls or other adverse weather conditions in time to recall aircraft aloft and to secure against damage of those on the field or on board ship. The importance of this information is emphasized at the large Naval air stations such as Pensacola, Jacksonville and Corpus Christi where several hundred students are being trained and where every minute of good weather must be utilized to permit full advantage of the intensive course of instruction.

On board ship at sea the aerologist is required to furnish the same exacting services, although his problems are multiplied a thousand times due to the lack of a network of weather reporting stations and in many cases a complete lack of any reports over several thousand square miles. This lack of information is largely overcome by the fullest use of the latest methods of synoptic weather chart analysis, special aerological instruments and a continuous watch by trained observers of all local weather changes.

The Chief of the Bureau of Aeronautics is charged with the supervision of aerological units ashore and afloat. The aerological section of this bureau is charged with:

1. Cognizance of all aerological equipment including estimates, design, procurement and the preparation of technical instructions.

(*Continued on page 178*)

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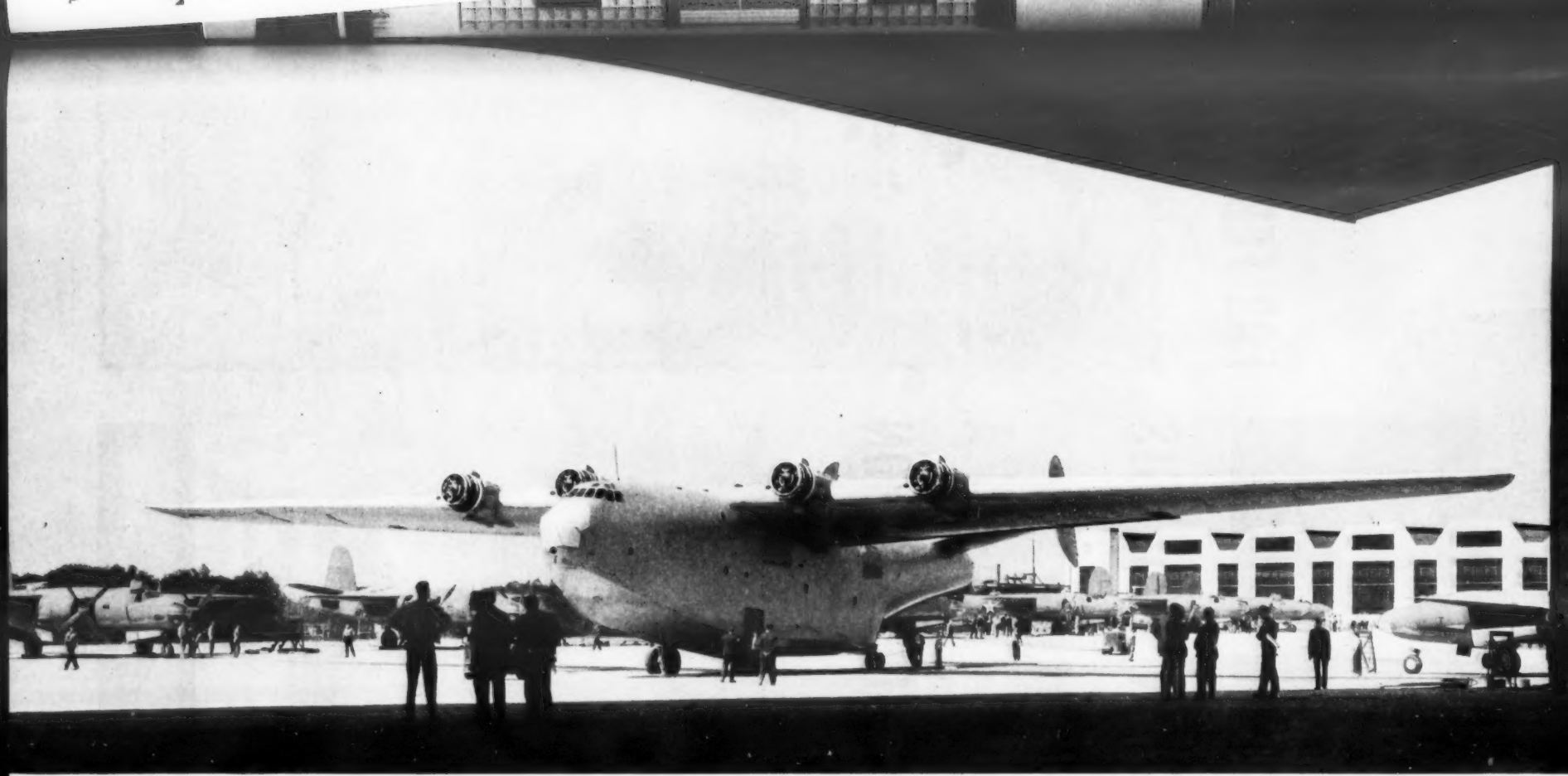

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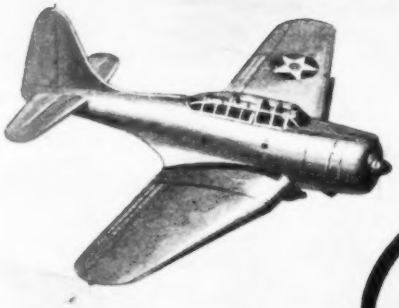

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(*Continued from page* 170)

2. Preparation of recommendations concerning operating plans, policy and other aerological matters requiring the attention of the Office of Naval Operations.

3. Recommendations relative to aerological stations ashore and afloat in cooperation with the Bureau of Ships, Bureau of Yards and Docks and the Bureau of Supplies and Accounts.

4. Supervision of Naval aerological development and experimentation. This includes the collection and dissemination of aerological developments by other agencies and in foreign countries.

5. Co-operation with the hydrographic office in disseminating aerological information to the Navy, preparation of aerological charts, etc.

6. Liaison with the Weather Bureau, Naval Communications, Army Air Corps and other organizations.

Soon after the Naval organization was established, new and improved instruments were designed to give accurate records of weather elements at sea. An accurate instrument for determining winds aloft from a moving ship was designed and perfected. An instrument for obtaining a record of the temperature and relative humidity, when taken aloft on an airplane, was constructed and produced commercially for use by other meteorological organizations. More recently, the radio sonde equipment was developed to obtain the temperature and relative humidity aloft under all weather conditions. This was made available to other organizations for research.

The latest development is an automatic weather station which can be installed on an uninhabited island. When placed in operation it will transmit automatically by radio, for distances of several hundred miles, regular observations of the surface wind force and direction, atmospheric pressure, amount of rainfall, air temperature and relative humidity for a protracted period of time without servicing. The present equipment is designed for 30 days continuous operation without attention, but it is expected that an improved design will be developed which will require servicing only once in three months.

All of this development and experimental work could not have been accomplished without the full co-operation and assistance of the National Bureau of Standards, the Bureau of Ships and the Naval Research Laboratory.

In the field of synoptic meteorology, the Naval Aerological Organization was one of the first to realize the possibilities of the polar front method which utilized air mass and frontal analysis for ocean forecasting where few or a complete paucity of ship reports might be expected. This method, developed by a group of Norwegian scientists during and immediately after the World War, placed great importance on the physical characteristics of the atmosphere from the surface to several miles aloft.

The Navy was the first to use this method in the United States and encouraged its adoption by other meteorological organizations as early as 1928. Since the adoption of this method by meteorological organizations in the United States, the terms "air mass," "cold front," and "warm front" have become familiar terms and further explanation of the concepts of the polar front method is unnecessary.

The present war has demonstrated repeatedly the paramount value of weather information ashore and afloat. The invasion of Poland, Norway, the lowlands and the sinking of the *Bismarck* serve as striking examples. The efforts of the Naval Aerological Organization to furnish increasingly accurate and broader information constitutes, especially during the present emergency, a very necessary and important service to Naval aviation in particular and to the Navy in general.

END

Radio

(*Continued from page* 159)

Bellevue, the graduates of which are, almost without exception, of the highest possible caliber. The course compares quite favorably with those of many civil colleges, and the training received, coupled with the graduates' practical experience, has provided Naval aviation with the services of the best possible operating and upkeep talent. Thus in the past, with a comparatively lengthy time available for training, the Navy could require that all radiomen be qualified materiel men as well as operators; but, with the rapid expansion of the Navy, necessitating the reduction of the time in training, some radiomen are trained as operators and others as maintenance men. For this reason radiomen, first class, are no longer required to be graduates of Bellevue in order to become chief radiomen.

A number of aircraft radiomen, by possessing special qualifications and by passing difficult practical and theoretical examinations, are promoted to warrant officer ranks from which they are eligible for promotion to commissioned warrant grade as chief radio electricians. The opportunities for promotion, coupled with the educational advantages have created a high *esprit de corps* within the Naval aircraft radio personnel.

The Bureau of Navigation details annually one or two Naval aviators to postgraduate instruction at the Naval Academy, followed by a year's postgraduate instruction at a civilian university especially qualified in radio engineering. This number commencing in 1942 will be increased to four officers annually. The officers selected for this assignment must have had experience as communication and radio officers in the various Fleet aircraft units and in key aircraft radio positions ashore. In addition, a number of officers who have shown interest and knowledge of aircraft radio matters have been advantageously detailed to radio duties.

In order to insure a permanent nucleus of skilled personnel in Naval aviation, civilian radio engineers are employed in the Bureau and at various stations for handling the myriad of details connected with procurement, inspection, overhaul, tests, storage and distribution. A number of reserve officers, possessing particular qualifications for work in connection with aircraft radio, have been called to active duty during the past year. These men, with sound reputations in civilian radio or aircraft industries, are particularly valuable to the Navy in times of stress.

The future limits of Naval aircraft radio appear boundless. The solution of future problems calls for the combined and continuous effort of everyone in the field of radio. The radio personnel of Naval aviation must be alert to utilize and eager to contribute to every advance in the science of radio if the efficiency and efficacy of the Fleet are to be met successfully.

END

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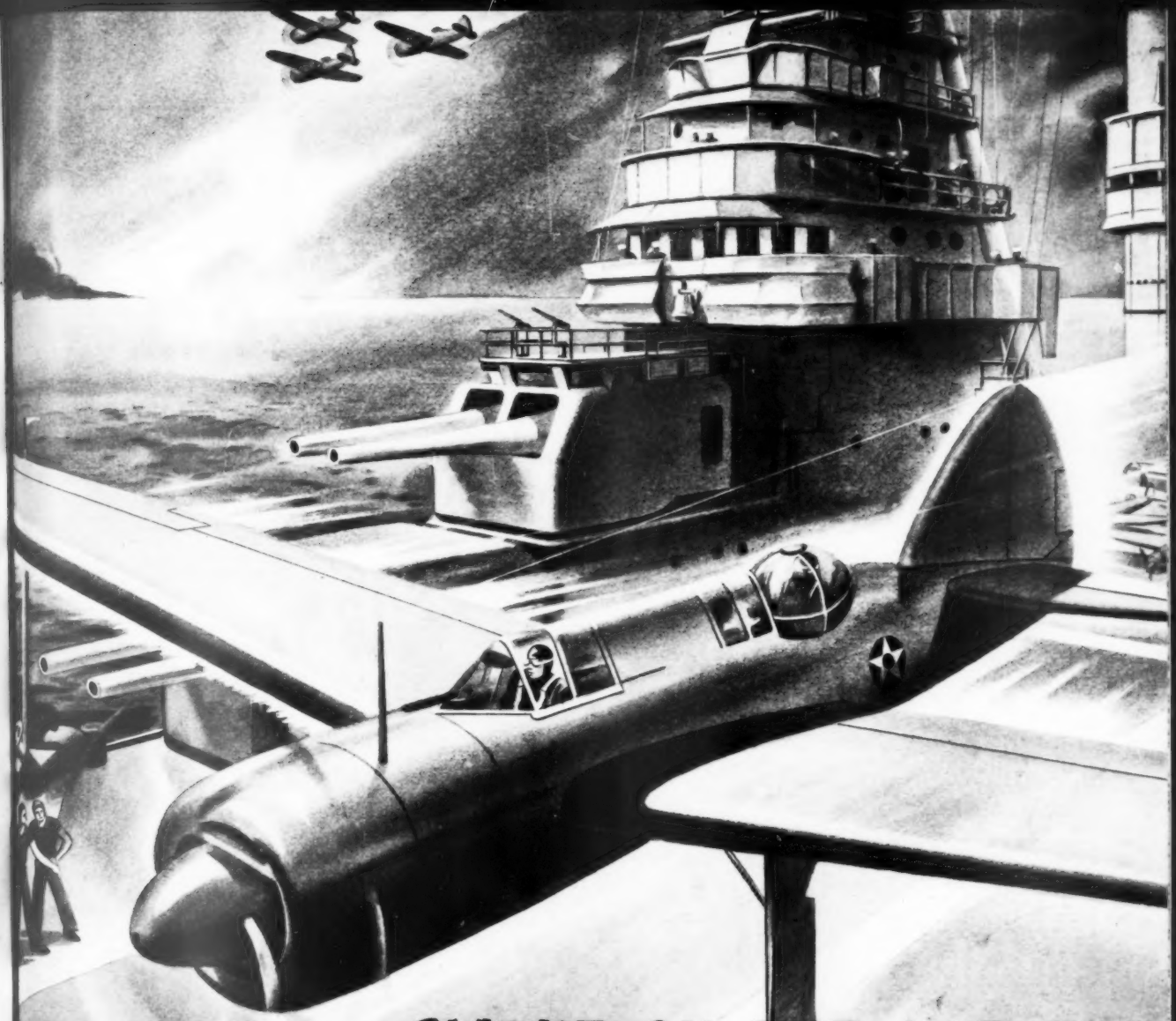

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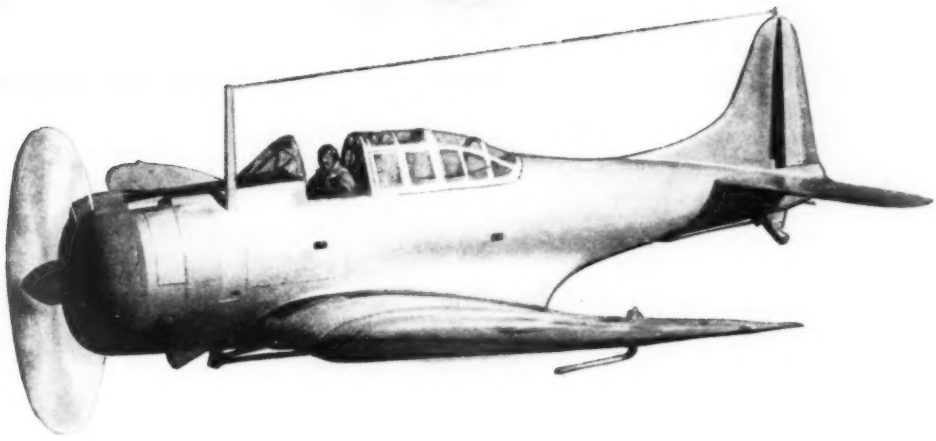

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Bureau of Aeronautics

(Continued from page 34)

maintenance of all aviation shore establishments of the Navy and the Marine Corps. Of prime importance to the Bureau is the problem of securing the highest grade of personnel available and of training that personnel to the finest possible state of efficiency.

To expedite the training program maximum use was made of existing facilities and a directive was issued authorizing the additional shore stations required. Shore facilities of the Naval air arm, as of October, 1941, comprised 29 Naval air stations in commission and four under construction. In addition, 16 U. S. Naval Reserve aviation bases are in commission, providing elimination flight training for prospective Naval aviation cadets.

The training of Navy aircraft personnel necessarily had to be co-ordinated with procurement and with the expansion of shore facilities. In June, 1940, the only existing Naval aviation training center was at Pensacola, Fla. The pilot entry rate was 100 students per month. By July, 1941, the Navy had three additional training stations at Jacksonville, Fla.; Corpus Christi, Tex.; and Miami, Fla., with a combined entry rate of 800 students per month. The training of enlisted personnel, mechanics, metalsmiths, ordnance men and radio men has reached the rate of 12,000 men every four months.

In carrying out its duty of providing the aircraft for Naval aviation, the Bureau recognizes the importance of research in all fields of aviation. The adaptation of aircraft to Naval needs affects almost every detail of design, including size and external appearance as well as invisible features, all of which call for extensive research in Government and private laboratories. Many operating defects in existing types of airplanes are thus found and eliminated and the solutions incorporated in new design.

Chemical and metallurgical laboratories are constantly working on the development of new alloys of greater strength, less weight and improved resistance to corrosion. Testing laboratories develop new structural combinations for the more efficient use of materiels. Wind tunnels produce data which make possible the development of new wing sections, new methods of reducing drag and increasing lift. Model basin tests make possible improved forms of floats and hulls. Engine laboratories produce new engines of greater power with less fuel consumption and improved reliability. Other laboratories are constantly at work on the improvement of radio, instruments, fuels, ordnance equipment, protective finishes and safety devices.

In spite of the increased loads in the form of ordnance equipment, radio and navigation aids carried by modern airplanes, structural strength and safety have been maintained. Drag reduction and increased engine power have kept the speed curve mounting. Reduction in fuel consumption has increased the range of all airplanes. Each advance made either by the Navy itself or by another agency in the field of aviation materiel is studied with the view of adaptation to Naval uses and Naval needs.

The increase in the number of airplanes from 1,000 in 1934 to approximately 5,000 today, combined with the increased performance demands and the new operational and maintenance problems which accompany higher performance airplanes, has boosted the materiel and equipment projects enormously.

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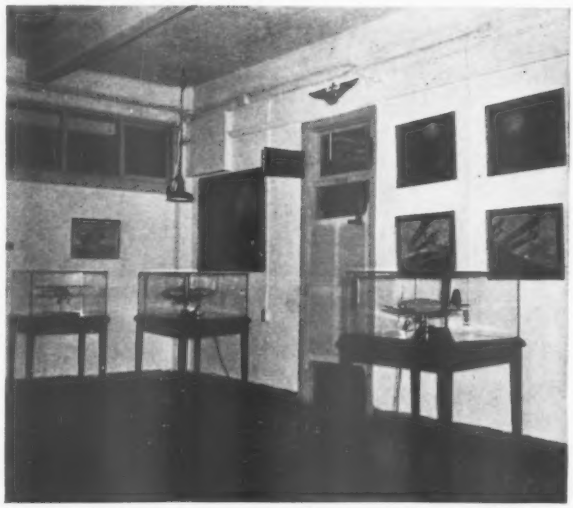


Behind this inconspicuous door in the Navy Building in Washington, Admiral Towers directs activities of U. S. Naval aviation.

The expansion of the Atlantic Fleet, acquisition of bases on British territory and increasing demands on patrol squadrons, resulted in a relocation and reorganization of both aircraft and supporting facilities. Constant operations and training are carried out in the Fleet. Ideas and methods developed in the current European conflict are analyzed, tested and applied to the use of our own Naval service.

The expansion of Naval aviation must be co-ordinated with the expansion of the Navy as a whole. New carriers will require their complement of planes, as will new battleships and cruisers. Additional squadrons of large patrol seaplanes are placed in commission as additional tenders and shore facilities are provided. It is true that the percentage of Naval aviation strength to total Naval strength is increasing, but it must not be assumed that the air Navy is supplanting the water Navy. The proper word is "supplementing."

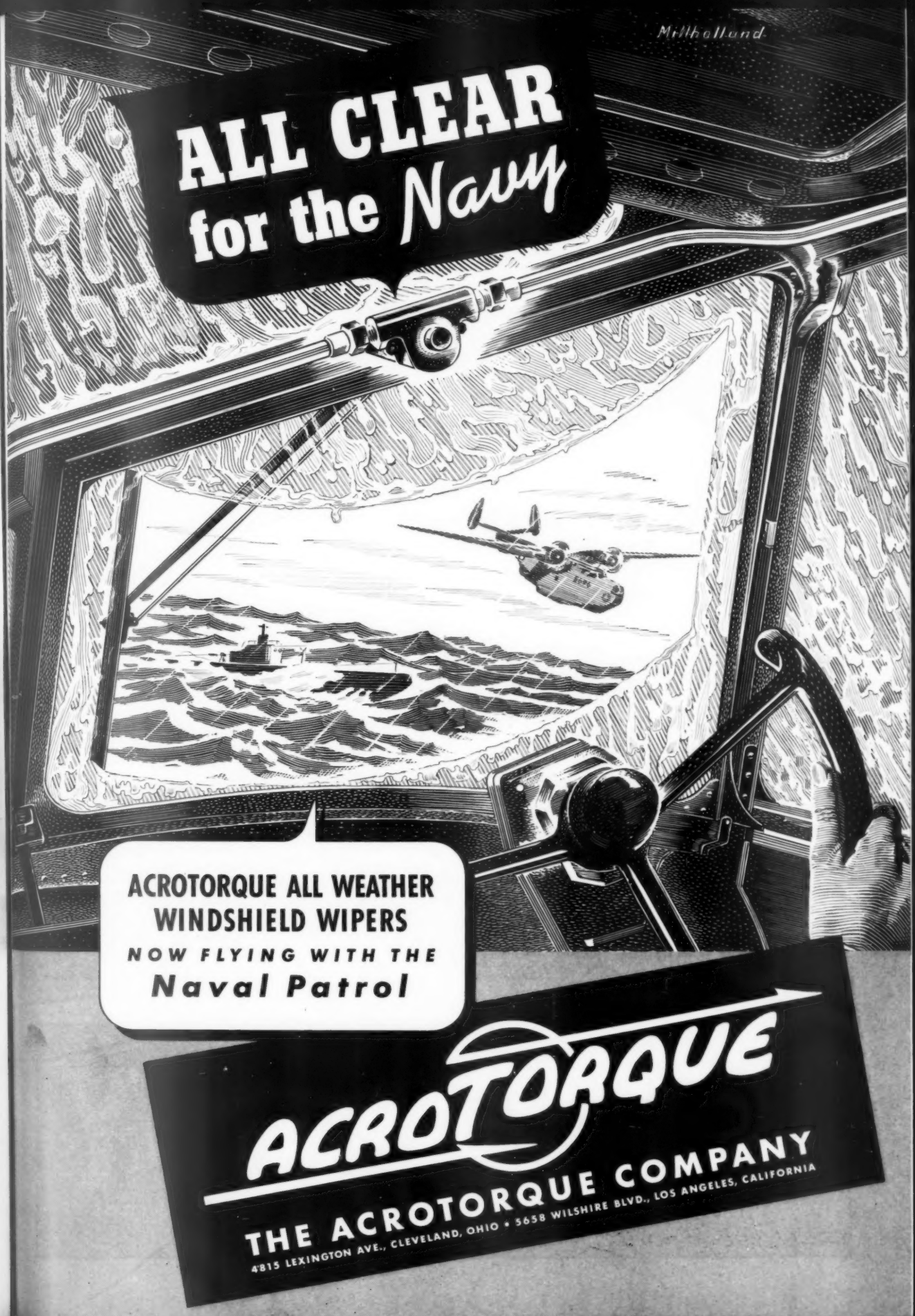
I am an aviation enthusiast, but I hope I do not allow my enthusiasm to get the better of my judgment. As I have pointed out on various occasions, I feel it necessary to express again a note of caution against accepting at their face value the many extravagant statements made at the war's beginning with such catch headings as "Battleships doomed," "United States open to air invasion," "Wars can be won in 72 hours by aircraft." The airplane is no panacea for offense and defense. It has its strength, such as speed, bomb-carrying capacity and elusiveness; but it also has its weaknesses, such as the handicap of weather, the inability to seize and hold land or water areas, and the time required to train personnel in its effective use.

A nation at war is capable of putting out a certain "national effort." This is limited by man-power, money, natural resources, industrial capacity and other factors. The directions in which these efforts are exerted depend largely upon the geographical and political situations.

Do not be misled either by aviation enthusiasts who have not bothered to study the history of warfare, or by students of warfare who have not bothered to study aviation. There is much wishful thinking behind their extravagant statements.

It is only natural that many of those directly concerned with aviation should praise its virtues and gloss over its shortcomings, just as it is natural that a statesman charged with financial responsibility for defense should seek methods which are cheaper and better. In addition, there is always the tendency to over-exploit the value of a new weapon. Give aviation its full due, but do not think of disposing of the battleship or the foot soldier! They have consolidated victories in all major wars heretofore and, in my opinion, will continue to do so for many years to come.

END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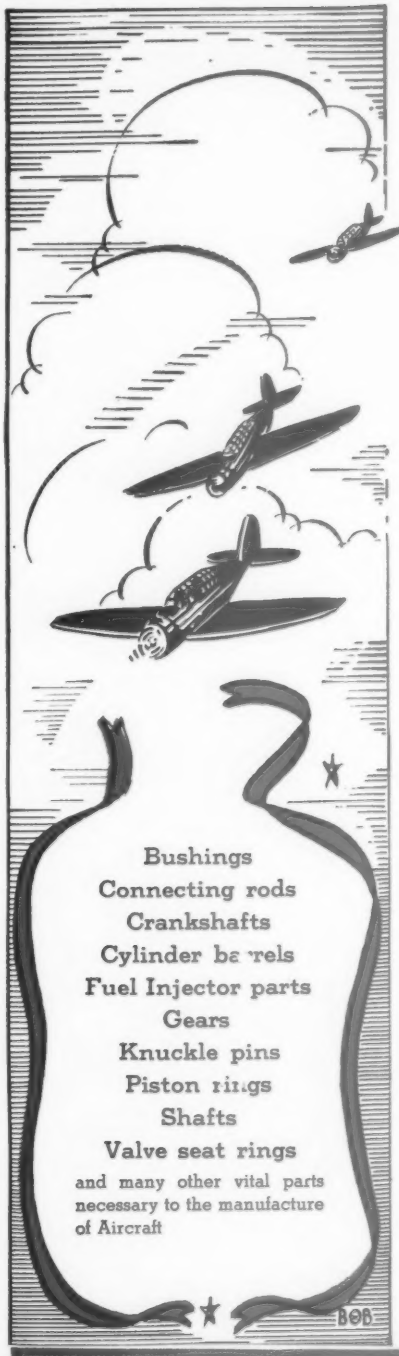

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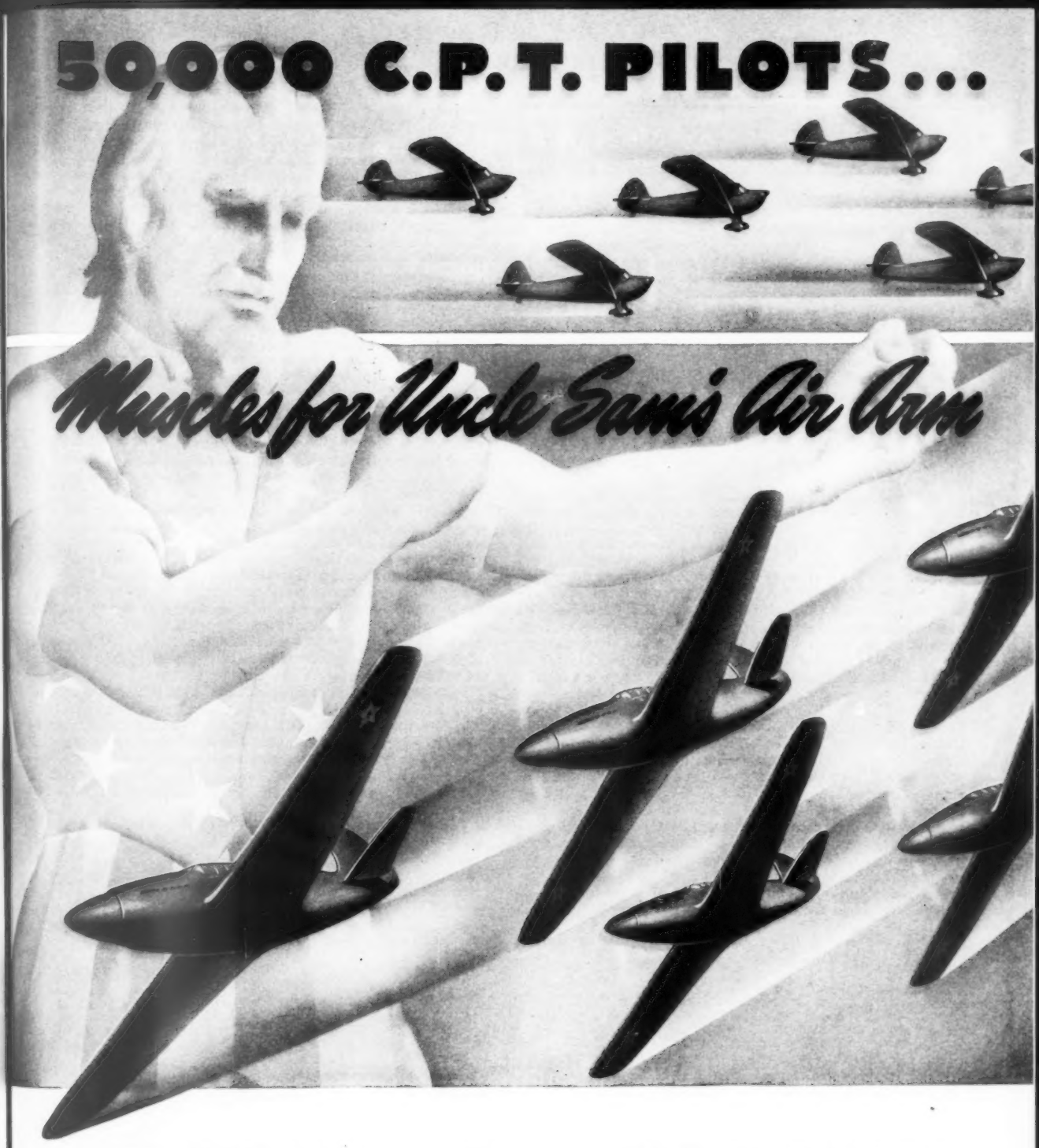

THE Civilian Pilot Training Program has already trained 50,000 pilots. The annual goal of 45,000 pilots is being achieved. By bending every facility, the fast expanding light plane industry is producing the ships that make possible the training of this vast reserve of potential Army and Navy pilots. An energetic group of companies has been given a big job to do and is doing it well.

Every month, production totals of Franklin-powered trainers set new records. Franklin is proud to contribute to the growing girth of Uncle Sam's muscles by building newer and finer power plants in ever increasing numbers.

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AIRCOOLED MOTORS CORPORATION ★ SYRACUSE, N. Y.

Maintenance

(*Continued from page* 135)

This is the average time and, of course, varies with different types and the service in which the plane has been engaged. Improved construction in recent years has reduced many overhaul and maintenance problems, but the severe usage to which Naval aircraft are subjected requires routine overhaul periodically to insure that they are at all times in fit condition to fly.

The period between engine overhauls is determined for each type and model of engine in operation and depends to a great extent upon how well that particular type or model has been performing. Poor performance necessitates more frequent overhauls. On the other hand, engines which are operating without difficulties do not require overhaul at such frequent intervals and the period of operation between overhauls is accordingly extended. Improved engine construction in recent years has tended to increase this interval. The period between engine overhauls is determined by the number of hours in the air.

Closely linked with and of vital importance to maintenance is the service of aviation supply. This is the service that conducts the supply and replenishment of spare parts, aeronautical materiel and equipment needed to maintain the planes in operation. With Naval aircraft operating in widely scattered localities throughout the Atlantic and Pacific areas, this sometimes proves difficult. Distribution points for supply have been established at all of the major operating and overhaul bases. In addition, centrally located supply depots have been established on both coasts, where reserve stocks of materiel are maintained for further distribution as required.

Naval aviation supply is a joint responsibility of the Bureau of Aeronautics and the Bureau of Supplies and Accounts. Control of the system is centered in the Aviation Supply Office, established at the Naval Aircraft Factory, Philadelphia. Under the general direction of the Bureau of Aeronautics and the Bureau of Supplies and Accounts, this Office conducts the procurement, distribution and re-distribution of aeronautical supplies and equipment. As directed by the Bureau of Ordnance, this Office also handles aviation ordnance materiels in a similar manner. Stocks of aeronautical materiels are in a continuous process of re-distribution as Fleet units move from one operating area to another. Centralized control is essential as a means of having materiel on hand where needed.

The developments in airplane and engine construction in recent years have been very rapid. Larger and better planes are being built continually. However, because of the urgent need for high speed and performance for combatant aircraft, it is not always possible to combine durability with this increased performance. Some types of planes which have been thoroughly tested prior to going into production have developed at times unforeseen defects after they had been in service for a period of time. Frequent changes in service models occur. Maintenance personnel must be constantly on the alert to detect defects before they can cause serious trouble and accidents.

It is necessary that Naval aircraft be designed to fly in all kinds of weather in the performance of their missions. Complicated instruments and accessories necessary for all types of flying are installed in these planes. They frequently become a maintenance problem, requiring constant attention.

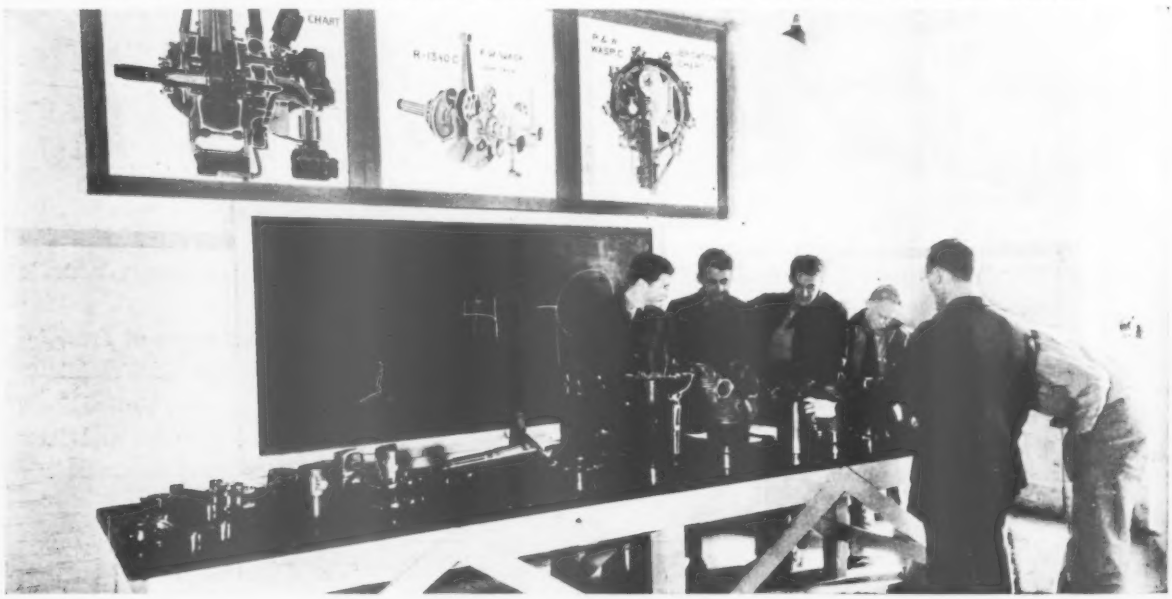
Consideration must be given to maintenance problems in the design of airplanes and engines. Standardization and interchangeability of parts are important. Accessibility for inspection of the parts of the power plant and accessories and those portions of the structure of the airplane subjected to excessive wear or stress must be taken into consideration when the plane is originally designed. Engine mounts should be designed so that engines and accessories can be changed with minimum loss of time.

An ever present problem confronting maintenance in the operation of Naval aircraft is that of corrosion. Planes operating from aboard ship are exposed a large portion of the time to the elements. Corrosion resulting from salt air and salt water spray must be carefully guarded against. Consequently materials used must have high corrosive resistant properties. Dissimilar metals must be separated to prevent the electrolytic action of salt water. Large patrol bombing flying boats are required at times to anchor out during the course of their operations. In tropical waters barnacles and undersea growths form quickly on the underwater portion of the hulls of seaplanes. Within a period of a few days, this growth is not only sufficient to effect seriously take-off characteristics but also to cause corrosion. This necessitates frequent removal of planes from the water for cleaning. Smooth surfaces for the underwater portion of seaplane hulls, which tend to reduce such growth, is an important preventive measure. Protective paints are very important and research work along this line is given high priority.

Continued attention on the part of manufacturers to the incorporation of good maintenance features in the original design of aircraft will be of great assistance to maintenance work. Considerable advancement has been made in recent years along these lines, with gratifying results.

END

Salt water corrosion, deadliest enemy of Naval aviation, must be anticipated in aircraft engines by constant inspection.



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Snogo can reduce the troubles and delays in winter training. Snogo means open camp streets, open camp roads and safer winter airports. Snogo leaves no dangerous snow banks that catch drifting snow, cause hazardous one way bottlenecks and expensive repeat plowing out. Snogo means open winter roads for faster winter military traffic.

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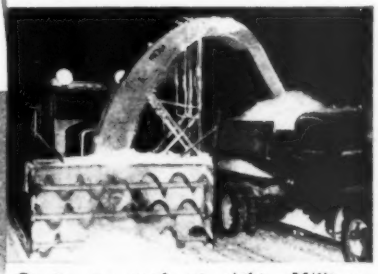

Snogo can work at night. Military grounds of all kinds can be clear in the morning.

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THERE IS A SNOGO FOR EVERY BUDGET — From a 1½ ton to the largest four wheel drive type of truck.

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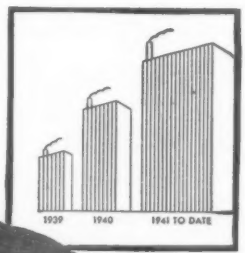
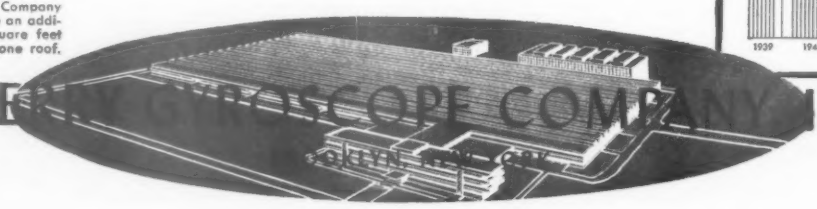
IN every corner of the land American citizens are asking, "How fast are we building the things we need?" Sperry's activities, linked as they are to the production pace of the aviation and shipbuilding industries, serve as a reassuring index.

Sperry must have its navigation instruments ready for every new Army or Navy combat airplane and for vessels of the Navy and the Maritime Commission. At the start of the emergency, Sperry already had far-reaching facilities for doing the job. Half a million square feet of plant area were teeming with production. As the American builders of ships and aircraft began their all-out effort, Sperry, to keep pace, added first two, then three, then four, then five hundred thousand square feet of factory area. Today, another vast addition is going up in Long Island. With its completion, Sperry will have two and one-half million square feet of factory area.

2,500,000 feet required for the manufacture of Sperry instruments alone! No finer tribute can be paid to the productive genius of American ship and airplane builders.



The new Nassau plant of the Sperry Gyroscope Company will make available an additional 1,350,000 square feet — 26 acres under one roof.



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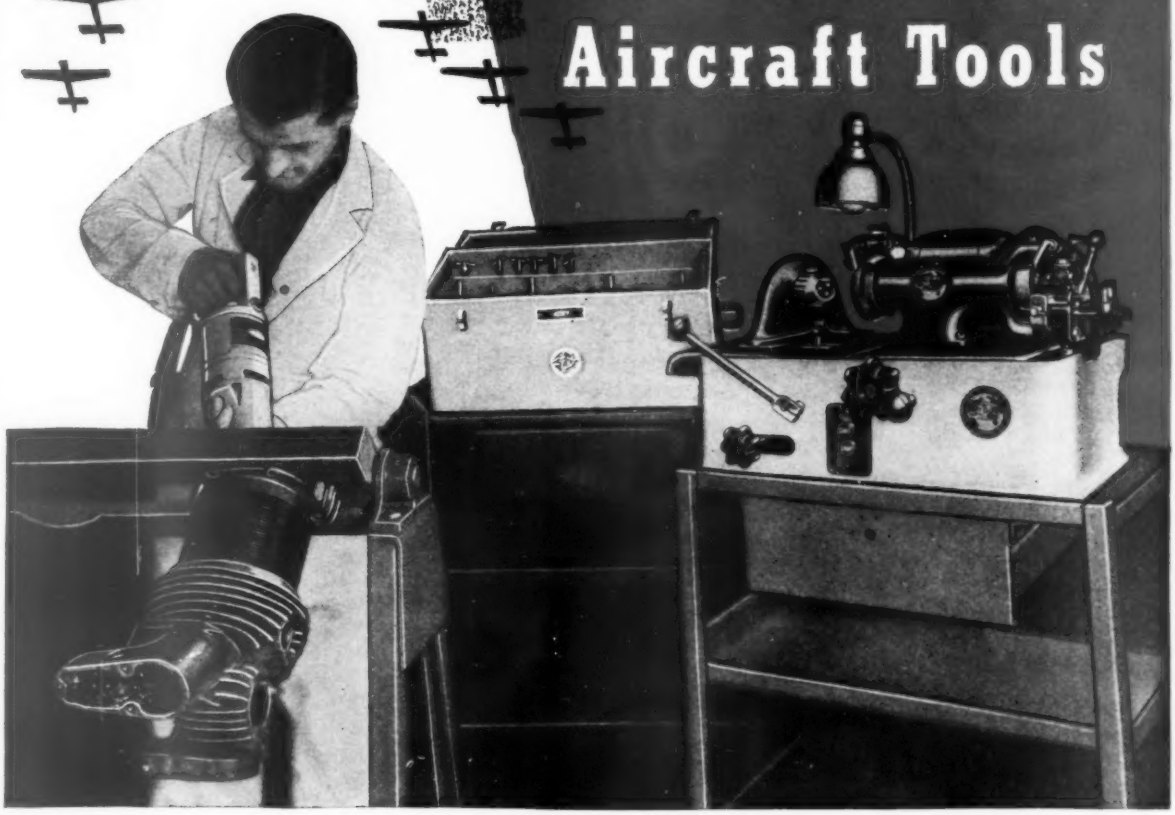

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For precision work in fast time—for smoother, more finished jobs, this machine meets all the requirements of both production and maintenance plants. It wet grinds all valves, any angle, including 90° flat valves. Grinding head easily adjusted for large or small valves. It wet grinds valve tappets and rocker arms to original efficiency.

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Ranger's light weight enables *both* cockpits to be set well forward. Hence a student, even in the rear cockpit as shown in this actual photograph, can see ahead and below, where he needs to see, in incomparably superior fashion.

Through thousands of hours every busy day, hundreds of Fairchild M-62 Ranger-powered Trainers (the Army's PT-19) thus waste less time pussyfooting on the ground, spend more time profitably training in the air.

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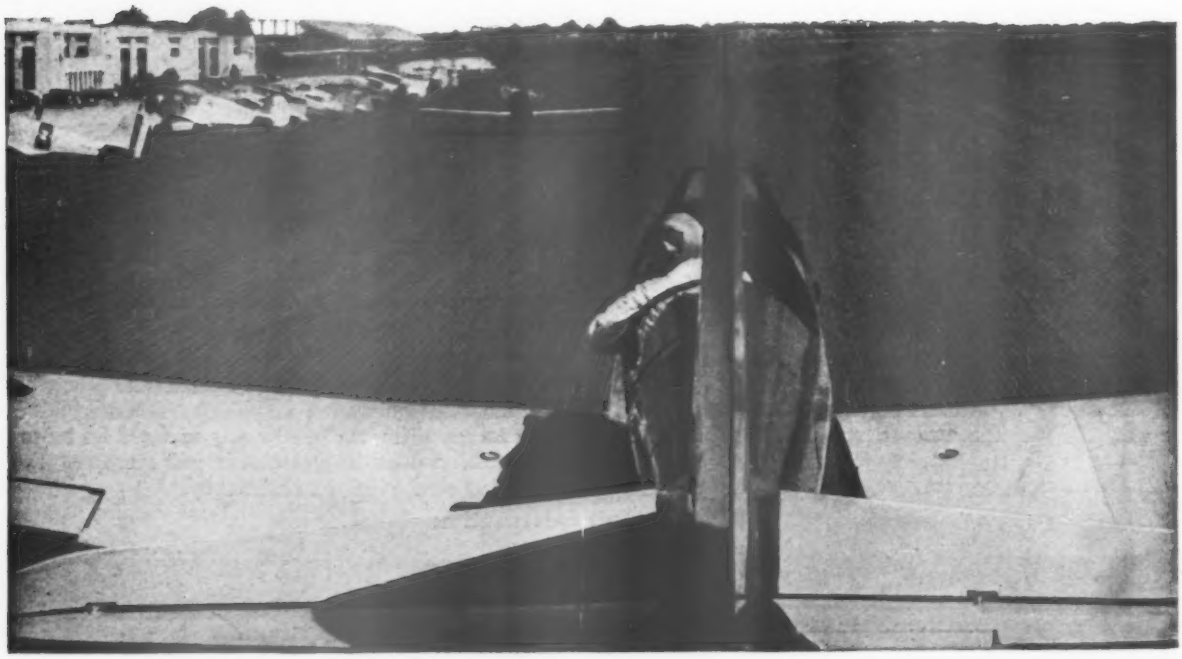


WRING IT OUT ALL YOU WANT

ALMOST any good plane can be safely slow-rolled by an *expert*. But the Fairchild Trainer was designed with an extra broad margin of stamina for the stresses imposed by the aerobatics of a beginner. After thousands of hours with the Army Air Corps, the CPTP, and the CAA, the Fairchild Trainer has amply demonstrated its tolerance for the abuse of the heavy-handed fledgling, as well as its sensitive response to the precision aerobatics of the experienced pilot.

And, right side up, that wide, rugged landing gear takes five-foot-high landings—prevents ground loops—assures continuous service *in the air*.

FAIRCHILD AIRCRAFT

Division of Fairchild Engine & Airplane Corp.
Hagerstown, Maryland . . Cable Address "Faircraft"

VSB—The Scout Bomber

(*Continued from page 70*)

limiting acceleration or threshold of black-out is not the same for every pilot. Some men are able to withstand a greater acceleration than others. The dive bomber pilot soon learns his acceleration capacity and regulates his recovery from dives accordingly.

Much experimental work in the field of medical research is now in progress which should result in the stepping of the pilot's resistance to higher accelerations. It is not enough, however, to be in level flight just above the ground or water. It is essential to be leveled off and away at an altitude which is sufficiently high to keep the airplane out of the danger zone of its own bomb. This danger zone varies with the different weights and classes of bombs carried.

A Navy pilot does not simply place the airplane in a dive and point his sight at the target as many persons believe. Accuracy in this type of attack depends upon flying the airplane at all times. The point of aim will depend upon the angle of dive, the force and direction of the wind and the motion of the target. Upon entering the dive, the pilot at once maneuvers to pick up the estimated point of aim, but it often happens that, as the dive develops, the sight will drift off the target. Should this occur the trained pilot will maneuver the airplane, while still diving, to regain a proper position from which a list may be obtained. A "skid" must be avoided, as a bomb dropped from a skidding airplane will be deflected or "thrown" yards from the line of sight.

Since the heavy bombs now carried by this type are usually mounted under the fuselage—namely, on the center line—it has been necessary to provide a device which will insure that the bomb is guided clear of the propeller or other parts of the airplane.

Once the bomb has been dropped, the pilot so controls the airplane that the "get away" is made as quickly as possible, frequently flying an erratic course at maximum speed.

As mentioned before, the Navy commenced dive bombing as a routine exercise as early as 1927. These practices were carried out with airplanes which were not designed to carry heavy bombs. In 1929, Boeing F2B and F3B fighters, and carrier scouts of the Vought O2U type were relied upon to perform dive bombing. These models could only carry two or four 100 pound bombs. Such bombs were of little or no value against vessels possessing armored decks, except insofar as they might drive the exposed antiaircraft crews to shelter.

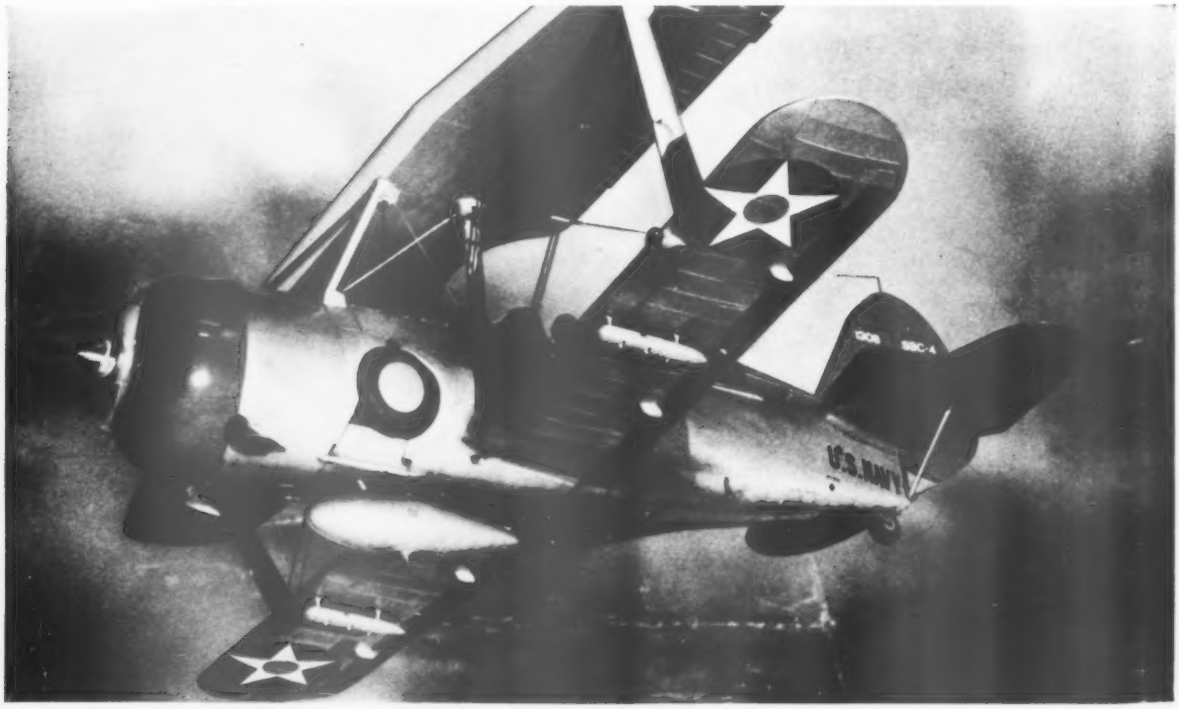
In 1930, the Curtiss F8C-4 or *Helldiver*, appeared in quantity. This airplane was designed as a two-seat fighter and dive bomber. Although the bombs carried were still small, the airplane was extremely steady in a dive and was very rugged. About the year 1931, the later modifications of the Boeing F4B series entered service. These single-seat fighters were stressed for dive bombing and could carry a single 500 pound bomb. In 1930 an exceptional airplane was introduced, the Martin XT5M-1. This airplane was a large biplane of fair performance. It could dive with a 1,000 pound bomb and, to the best of my knowledge, was the first airplane in the world to accomplish such a feat. It might be well to point out that it is always necessary to provide sufficient strength in the airplane to permit a recovery from a dive with the bomb still attached. It was this feature that made the performance of the Martin XT5M-1 remarkable for its time. This airplane was followed in 1932 by the production version which was designated the BM-1. The BG-1 airplanes followed the BM-1's and were identical in all respects.

In 1935, as previously mentioned, the Vought SBU-1 was introduced and, from this year to the present, we find the carrier-scout and the dive bomber missions combined in one class of airplane.

Two years later, three new types of VSB airplanes entered Naval service: (1) the Curtiss SBC-3, a high-performance two-seated biplane with retractable landing gear, powered with the Pratt & Whitney *Twin Wasp Junior* engine and fitted with dive flaps to retard the speed. (2) The BT-1, while carrying the old bomber designation, was actually a VSB type—a low wing, two-place monoplane of high per-

(*Continued on page 194*)

Highly successful Navy scout bomber was Curtiss SBC-4. Widely used in 1939, SBC-4 had estimated top speed of 235 m.p.h., cruised at 197. British have several and have renamed them "Clevelands."



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When we say fast, we're talking about a guaranteed cruising speed of 120 M.P.H. with a top of approximately 140 M.P.H.

When we say safely, we're boasting about engineering's most outstanding structural contribution to the light plane field in the last decade.

When we say economically, we simply echo the testimony of hundreds of Culver owners who fly at an operating cost of 1c per mile.

When we say modern, we're seeing the trim lines and retractable landing gear which make Culver the most modern ship in the light plane field.

Write for your flight in a Culver and after your thrill ride, you'll say, "There is a Santa Claus" — for Culver performance will restore even your faith in Santa Claus.

Do your Christmas writing early — for Culver literature.

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CULVER

(*Continued from page 192*)

formance, with landing gear partially retractable and the wing fitted with dive flaps. (3) The Vought SB2U-1 was an airplane of exceptionally good performance for this period and the first of the SB type to be equipped with folding wings. It is a two-place, low-wing monoplane powered by the Pratt & Whitney *Twin Wasp Junior* engine of 750 h.p. and fitted with the Hamilton Standard constant speed propeller. Its structure is all-metal with fabric covering on the movable tail surfaces and on the after portions of the wing and fuselage. The landing gear is fully retractable. The SB2U-1's were followed by the SB2U-2 and SB2U-3 series.

Developed from the Curtiss SBC-3 airplanes, the SBC-4 entered service in 1939. This two-place high performance biplane is powered with a large Wright engine and represents the last biplane of the VSB type to be purchased for the Navy. Due to space considerations on board the carriers, the biplane was the preferred type for years. Modern design and power-operated wing folding now permits the use of monoplanes and it is extremely doubtful if the biplane type will again come into carrier service use.

In the summer of 1940, the present standard scout-bomber was introduced in quantity. Developed from the BT-1, the Douglas SBD series provide our squadrons with an airplane having performance superior to any single-engined dive bomber in the world. This series includes the SBD-1 for the Marine Corps, the SBD-2 and SBD-3 for the Navy and the SBD-3A (Army designation A-24) bought by the Navy for the Army.

In the very near future two new designs will be placed in service and will, beyond any doubt, provide our Navy with the finest dive bombers in the world. These airplanes are the Curtiss SB2C-1 and the Brewster SB2A-1.

The supremacy which our Navy enjoys in the dive bomber field has been earned by constant research, training and practice. New designs are constantly being laid out on the drafting board and experimental airplanes are being quietly constructed in order that this supremacy shall be maintained.

END

Naval Operations and Aviation

(*Continued from page 28*)

The Fleet Marine Force is being prepared to accomplish its mission in amphibious warfare by equipping it with an adequate number of aircraft, manned by its own Marines and ready to operate from ship or shore as circumstances require. This force must be thoroughly trained in the highly specialized operations of amphibious warfare which require the utmost co-operation between air and ground.

The task of providing without delay airplanes, flight crews and ground personnel for our new aircraft squadrons is a difficult and exacting one. It has necessitated the creation of new aviation training schools for both officers and men and has required the acquisition of large quantities of equipment, the construction of new aviation facilities on shore and the recruiting of large numbers of men for Naval aviation duty. The future success of our active air operations at sea depends in no small measure on the thoroughness of the preliminary training given on shore. Accordingly every effort is being made to maintain a very high standard in our training institutions and to provide them with the best possible material.

Time and space do not permit detailed descriptions here of all the various phases of Naval air operations, nor of the various types of splendid aircraft now being produced by the aircraft industry to equip Naval aviation to perform its functions. They do permit the Chief of Naval Operations to take this opportunity to express his pride in the aviation component of the United States Navy as it has existed in the past, and his confidence in its ability to cope with the many difficult problems involved in expanding its strength under the present program. No small part of this confidence is due to the able leadership of our experienced Naval aviators, of whom some have progressed into the highest ranks and all of whom have been trained in the two-fold requirements of a Navy which includes air power as a principal element of its strength.

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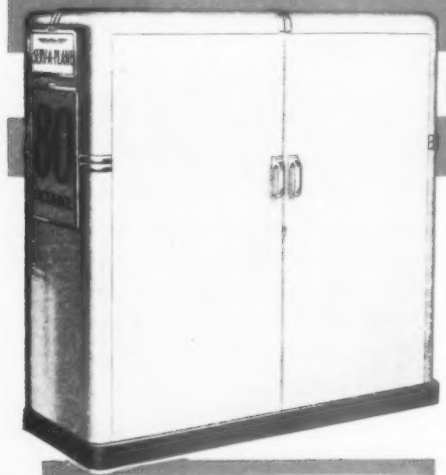

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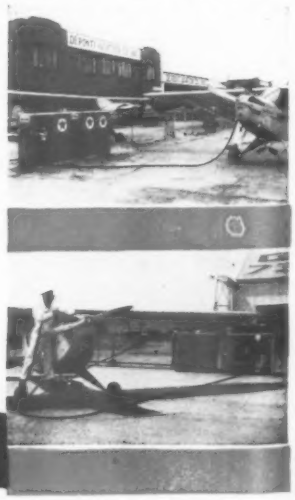

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The Birdmen's Perch

We've come to the conclusion that our public can't take it. First they were clamoring for really tough problems. So we ran them. Then what happens? The fellows who had been doing most of the yelling fold up and silently steal away. Only a few hardy souls, such as the fellow below, can answer those stickers. Shall we go back to diaper-days problems, boys?

Major Al Williams, alias, "Tattered Wing Tips,"
Gulf Aviation Products Manager, Gulf Bldg., Pittsburgh, Pa.

WOOING THE MUSE DEPT.

There's something about a plane that moves more people to poetry! Here's the latest to reach our desk. It's from Miss Bonnie Walters of Omaha, Nebraska.

The plane in the hangar stretched its wings,
And gave a mighty yawn,
He thought as he wriggled his piston rings,
My, what a beautiful dawn!

He partook of his breakfast of gasoline,
And out on the runway he rolled,
Then, glancing to see if his face was clean,
Up into the air he strolled.

He impolitely scared a tree,
By zooming far too low,
Then looking up, what did he see!
It brought him grief and woe.

For soaring high above him,
He saw his girl friend, Jane,
She was acting coy with Tailspin Jim,
Oh, it gave him a pain.

So up he went with a mighty roar,
And knocked Jim in a spin,
He watched him hit the floor
And then, took Jane back down with him.

Jane thought that he was wonderful,
And softly rubbed wing tips,
She praised him till the little plane's heart,
Was doing backward flips.

The little plane was very gay,
His head was in a cloud,
Then he and Jane went off to play.
They both were very proud.

THIS MONTH'S BRAIN TWISTER

Robert Smith, of Hamilton, Ontario, is one of the fellows who thinks our "tough" problems are just sissies. So he sends in one of his own. What can you do with it?

A flying hunter took off and started to fly due South. After he had traveled 100 miles he had seen nothing, so he turned and flew due East. At the end of 100 miles he spotted a bear on the ground so he landed and shot it. He then took off again and flew 100 miles back home. What was the color of the bear? (Ouch!)

IT PAYS TO BE CRITICAL

A great author once remarked that good literature often depended upon a man's ability to cut his own writing ruthlessly. The man, who could go through his own brain child, remove *every* extraneous word —*he* would have something worthwhile when he got through!

We use the same system in producing Gulfpride Motor Oil. We are constantly

critical of this oil. We are never satisfied with removing just enough impurities from it. We go even further and by a special process of refining—the Alchlor Process—we remove *more* of the carbon and sludge-formers that often can be so costly to an airplane engine. We think the success of Gulfpride Motor Oil proves that it pays to be mighty critical—especially of your own products!

WHOPPER OF THE MONTH

Dear Major,

I operate a loop-o-plane in a carnival. Maybe you've seen a Loop-o-plane. They're little four-seated buckets that whirl around on a pole. A motor revolves the pole.

Well, one day I was cleaning up the motor, waiting for the evening trade to start, when quite by chance I spilled a little G.A.G. on

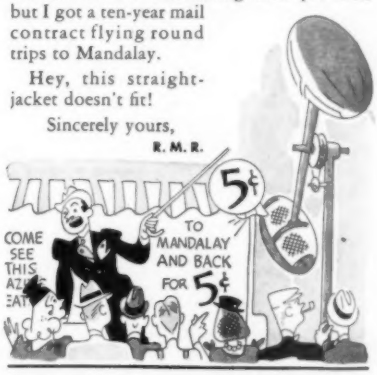
the motor—you'll notice I said *on* the motor. Just then a customer appears so I hop down and sell him a ride. Well, I no sooner touch that switch and turn my back than the danged thing whirls around twice and shoots the car up to substratosphere levels. After it circles it heads west at four hundred m.p.h. and disappears. Not having heard of a preceding similar situation, I set down to think and darned if after half an hour it doesn't zoom over the roller coaster and make the prettiest hook-on landing on its whirligig.

After the passenger recovered he filed suit for twenty grand, which just cleaned out my Irish sweepstake winnings. I was going to sue G.A.G. for underrating their products but I got a ten-year mail contract flying round trips to Mandalay.

Hey, this straight-jacket doesn't fit!

Sincerely yours,

R. M. R.



Gulf Oil Corporation and Gulf Refining Company . . . makers of

GULF AVIATION PRODUCTS

CONTROL LIGHT
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MARKS
POLARIZATION
PLATES

In Aviation as in many other industries — particularly those engaged in national defense work, there is a growing realization of a natural hazard—and the vital need for controlling it. The hazard — "glare light". The control of it — Marks Polarization Plates. The dangers existing from obscured vision, uncertain detail, ground haze and other causes plus the advantages to be gained in aerial photography make the inquiry about these Marks Polarization Plates a matter of first rank importance to every flyer and executive in Aviation.

KIN-O-LUX INC.
105 WEST 40 ST. • NEW YORK CITY

Naval Air Station

(Continued from page 153)

and must be performed by especially trained mechanics under the supervision of personnel responsible for the flight status of the plane. Engines are completely disassembled and overhauled after a certain number of hours of flying time. This upkeep work must be carried out at a place from which planes can operate and at which they may arrive and from which they may depart under their own power, whether it be a landplane or a seaplane.

Hence, a Naval air station is essential to carry on the upkeep and maintenance work and to provide living accommodations for both the flight and ground crews of the planes it is required to support. Further, major air stations are equipped with complete facilities for the operation, storage, supply and major overhaul of engines and hulls of all types of planes.

To deny an airplane its Naval air station facilities would be to deny its very existence.

The Navy has proceeded with great speed in the construction of the necessary Naval aviation shore facilities. A number of factors are responsible for the success in getting this tremendous construction program under way quickly and prosecuting it expeditiously. Some of these reasons are:

Much of the work had been planned in advance and basic design work completed even before moneys were available.

Standards had been developed for layouts with types and plans ready.

A well-trained nucleus organization, capable of rapid expansion had been developed both within the Bureau of Yards and Docks and in the field.

By decentralization and granting of broad authority and responsibility in the field many delays were avoided.

Required designing, detailing and engineering beyond the capacity of the organization of the Bureau of Yards and Docks and its field forces under a normal work-load were accomplished through contracts with private architectural and engineering concerns.

The cost-plus-fixed-fee type of construction contract by its flexibility has enabled the Navy to initiate work promptly and push it energetically.

The spirit of loyalty, co-operation, enthusiasm and pride in the job at hand has been developed not only among Navy personnel but likewise among private architects, engineers and contractors and their employees, all of whom are working together as partners to accomplish a vital National Defense effort.

As President Roosevelt has said, "Our Fleets far out in the Atlantic and Pacific, yes, the Naval forces that support them in our far flung bases, the magnificent air arm of the service and the night and day shifts working in the Navy yards to keep our two-ocean building program ahead of schedule—all these various agencies are now highly integrated."

In conclusion, it may be stated that the Navy's aviation shore expansion program is being executed in an orderly manner and will assure the readiness of facilities as the planes become available. As previously mentioned, the basic pattern was laid some years ago and was definitely fixed and developed by the recommendations of the Hepburn Board report of December, 1938. While it has been expanded as the result of world conditions, the entire program is capable of such further expansion as may be found necessary to meet the ultimate requirements of Naval aviation operations.

END

Give Yourself a Break...
Don't Break Yourself!
BUY YOUR AIRPLANE ON EASY TERMS the ACC way

Easy as buying a car—to own your airplane the ACC way. Find out about ACC insured finance plans.

Low Down Payment • Easy Monthly Installments

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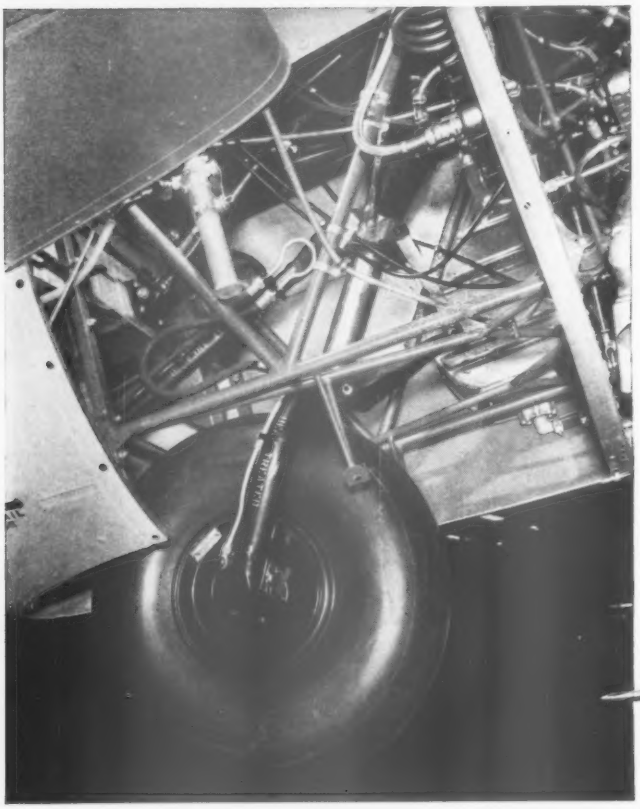
VULTEE BASIC TRAINER FOR THE U. S. NAVY

WHOEVER RULES THE AIR
WILL WIN THE WAR AND
WILL DICTATE THE PEACE

VULTEE AIRCRAFT, INC • VULTEE FIELD, CALIFORNIA



Amazingly Fine Workmanship

Inside of a nacelle—only one unit of the amazingly well built Cessna—yet here is the story of a revolution.

Not many years ago airplanes were almost completely hand made. Nearly all parts had to be laboriously fitted to the individual plane. Mass production was *talked* about, back in the '20's. It was still being *talked* about in the '30's. But not until last year did airplanes start rolling down production lines.

At the Cessna factory thousands of parts, all produced on precision machines, began moving continuously forward, and were quickly assembled. Faster and faster this line moved as the need for military airplanes increased.

The tooling that made this possible has brought amazingly fine workmanship on Cessna airplanes and — when this emergency is over — much lower costs for you!

Standardized INTERCHANGEABLE Parts

No Drifts

A drift is a compromise tool — used to pull two machined parts together when machining is not exact. No drifts are used at Cessna. Parts must fit, and do fit. Measurements are exact — parts are standardized and interchangeable.

CESSNA
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THE TIMM Aeromold TRAINER

Trim as a torpedo . . . a pilot's airplane . . . this sweet-flying trainer has an impressive ease of maneuverability that cuts hours from advanced acrobatic training time . . . Its sleek and seamless aerodynamic efficiency produces flying characteristics that resemble those of a fighter.

The TIMM TRAINER features Aeromold plastic-bonded plywood throughout . . . in fuselage, wings and tail surfaces . . . repellent to water, oil, bacteria or fungus . . . highly resistant to fire and shock.

Uninterrupted use of the operator's investment is built into its sturdy strength. Designed to take the constant pounding of student instruction, the TIMM AEROMOLD TRAINER offers new low costs of maintenance, ease and speed of repair.

for the U. S. NAVY MODEL N2T-1 and for CPTP Contractors MODEL PT-220-C

Flight view of the TIMM model S-160-K, fully approved for CPT secondary training programs.

TIMM AIRCRAFT Corporation

LOS ANGELES METROPOLITAN AIRPORT ★ VAN NUYS, CALIFORNIA

★ Fabricators of Aeromold plastic-plywood parts and metal sub-assemblies for leading aircraft manufacturers ★

Announcing THE SPECIAL

NATIONAL DEFENSE ISSUE

The MOST IMPORTANT PUBLICATION IN THE 25-YEAR HISTORY OF RADIO NEWS

THIS month the editors of FLYING AND POPULAR AVIATION's sister magazine, RADIO NEWS, are publishing the most important edition in its history . . . the special National Defense issue—an exclusive, fact-filled, picture-packed report of radio's vital role in National Defense. So significant are the functions of radio in the Armed Forces and in Civilian Defenses that the entire January, 1942, volume of RADIO NEWS will be given over to National Defense radio. In this forthcoming volume—on sale December 26th—leading officers and outstanding authorities in every phase of the field will give a graphic description of radio in the Army, Navy, Coast Guard, Marine Corps, and Civilian Defenses. By all means—don't miss this revealing, informative, comprehensive account of the activities of radio-trained men and the use of radio equipment in America's Armed Forces and Civilian Defenses.

Features:

Radio in the ARMY
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Artillery
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Infantry
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Radio in the NAVY
Radio Ashore and Afloat
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Radio in the COAST GUARD
Land and Sea Equipment
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Qualifications

Radio in the MARINE CORPS
Equipment
Training
Opportunities

CIVILIAN Radio Defense
Civil Aeronautics Authority
Amateur Radio Nets
Police Networks
Broadcast Stations
National Youth Administration
Aircraft Warning Nets
FCC Monitoring Stations
CCC Networks

SPECIAL JANUARY ISSUE
RADIO NEWS
AT ALL NEWSSTANDS DEC. 26TH

Power Plants

(*Continued from page* 140)

1,820 cubic inches, before the double rows came into existence.

The torque variations in the larger powers at that time were thought to be too large to permit any future increases in power. They were followed by radial engines with a double row of cylinders which, after considerable development troubles, passed their tests and were adapted for service use.

In the meantime, the liquid-cooled adherents had provided plenty of competition and forced the air-cooled exponents to extend themselves. The Curtiss developments—the D-12, the *Conqueror* and the *Super-Conqueror*, had given good accounts of themselves in the Army Air Corps. While Packard had the V-1300, V-1500 and the V-2500, the Wright company had T-2 *Tornado* and its later developments. Competition was keen and healthy between the liquid- and air-cooled schools of thought. Spurred on by the respective services, considerable strides were made. Low installed weight, high power output, ease of maintenance, reliability and low fuel consumption for cruising powers were all desirable features, but somewhat incompatible, and engineering compromises had to be made.

With the success of the R-1340, or *Wasp*, mechanical geared supercharging became necessary. Proponents no longer spoke of them as rotary diffusers, but as superchargers. Their use, however, provided increased powers for take-off but increased the minimum fuel consumption so necessary for long range performance. It was evident that considerable work had to be done to reduce the consumption.

Various ways were investigated, the use of higher compression ratios, requiring better fuel, special fuels, more cooling, fuel injection and diesels. As the latter have been highly publicized, some explanation of the history of this investigation is worth the digression. It shows in what manner aviation research helps indirectly other forms of transportation.

Imbued in 1924 with the belief that it was practicable to build a light, high speed diesel engine, which was contrary to all established engineering opinion, the Bureau of Aeronautics contracted with Eastern Engineering Corporation for a small prototype aviation engine of 120 h.p. designed by Andre Attendu, a naturalized Canadian. This engine, although somewhat impractical in certain features, demonstrated to the world that it was perfectly feasible to operate a diesel at high speeds. The actual tests were run at the Aeronautical Engine Laboratory. Many others then were ready to follow the lead of the Bureau. With this experience as a basis, the Allison Engineering Corporation, three years later, was persuaded to undertake a large six-cylinder, 900 h.p. engine for airship use.

On the other hand, a large manufacturing company of unlimited resources, which had a large industrial diesel manufacturing plant with 20 years or more of manufacturing experience behind it, was not so successful. It contracted in 1928 to build a 1,000 h.p. water-cooled aviation diesel of 24-cylinders, weighing 3,300 pounds. This project failed and the corpus delecti now reposes in the museum.

The Packard Motor Car Company, which had been building aviation engines for the Navy, was more successful. In 1930, the two radial, air-cooled engines of 255 h.p. under contract were actually delivered and one was the second diesel engine to be placed on test at the Aeronautical Engine Laboratory. This company spent several million dollars and produced more than 20 engines before dropping the development due to the death of their engineer.

This experience sobered the industry and it was not until 1934 that the Guiberson Diesel Engine Company was willing to guarantee a reasonable performance on a contract. This engine's performance was sufficiently encouraging to warrant a second contract in 1936, which resulted in that engine successfully passing a 50 hour test at the Aeronautical Engine Laboratory. These engines in a slightly larger size are now used for powering various Army combat vehicles.

Although the diesel engine has bettered its fuel economy during the past 10 years, the conventional Otto cycle has managed to equal or beat it. The development work is not being discontinued as the freedom from fire or explosion haz-

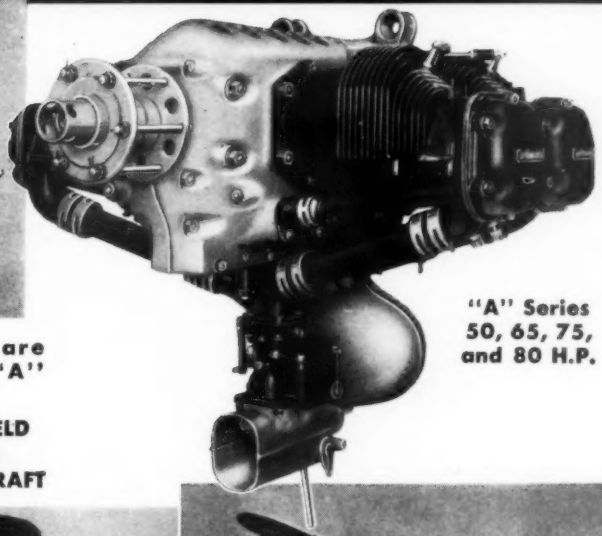
(*Continued on page* 236)

CONTINENTAL ENGINES ARE FIRST CHOICE FOR TRAINING PURPOSES

Continental

RED SEAL Trainer Engines

CIVILIAN • PRIMARY • BASIC



"A" Series 50, 65, 75, and 80 H.P.

The following light aircraft for CPTP are powered by Continental Red Seal "A" Series Engines.

AERONCA	INTERSTATE CADET	PORTERFIELD
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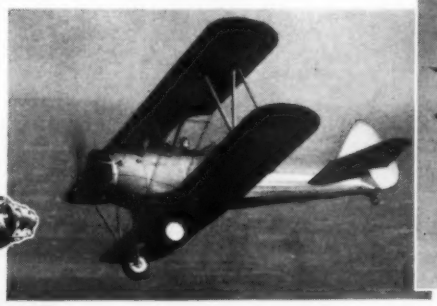
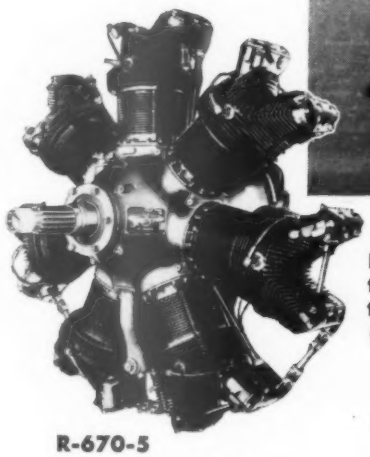


A Stearman Trainer

For Civilian Secondary Training, the Waco, powered by Continental W-670 is doing the job.



R-670-5

For the Army PT-17 trainers and the Navy N2S-1 and N2S-3 trainers, the Continental R-670 (220 H.P.) has proved its worth.

and NOW! The R-975,

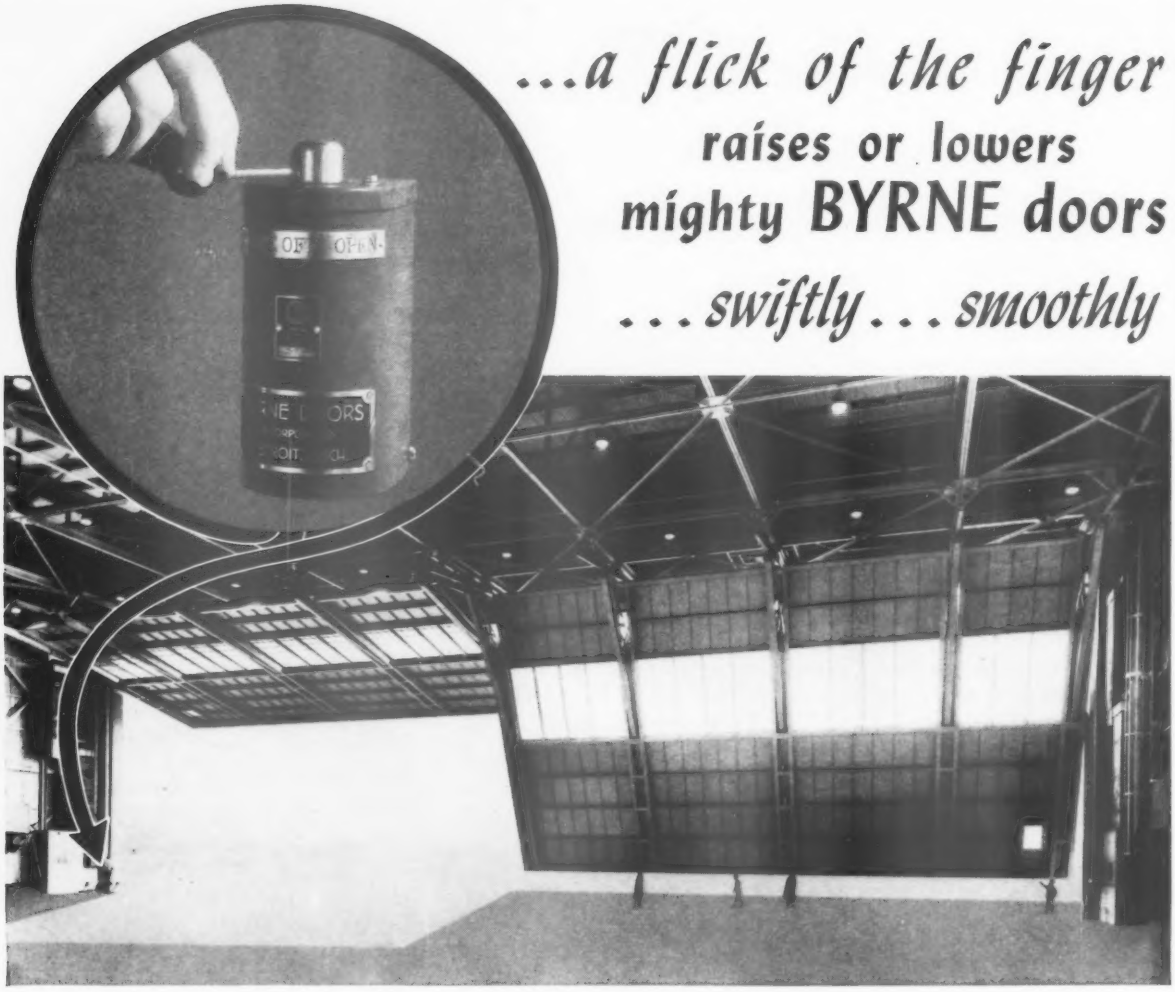
a 400 H.P., 9 cylinder air-cooled radial engine for basic training has passed the tooling stage and is coming off the production line daily in increasing quantities.

Continental Motors Corporation

Aircraft Engine Division

MUSKEGON, MICHIGAN

...a flick of the finger raises or lowers mighty BYRNE doors ...swiftly...smoothly



A single control . . . small as a man's hand . . . opens or closes a huge, perfectly-balanced Byrne Canopy Door in a matter of seconds. Thus, a clear opening, 200 feet wide, perhaps, or even wider, is quickly available . . . or as quickly closed. Byrne Doors can be engineered to any width, any height, any clearance. Co-operation in the design of hangar doors of any type will be gladly extended by Byrne engineers, qualified by more than 20 years' successful experience.

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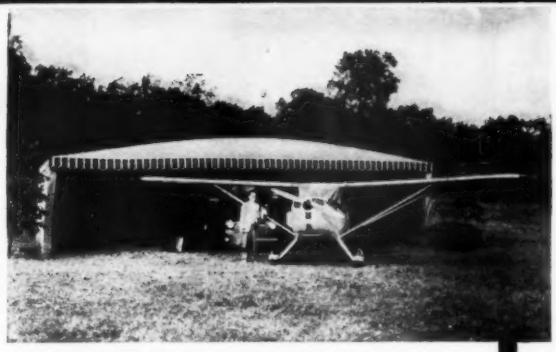
SOLVE YOUR STORAGE PROBLEM

Order This New Steel Frame Hangar For Your Plane—

CAN BE ERECTED IN 5 HOURS



With hammer and pliers the prefabricated steel frame hangar can be set and ready for use in 5 hours.

STURDY SAFE ATTRACTIVE

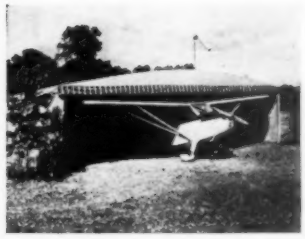
Carefully designed and engineered by aviation authorities, the heavy canvas cover has been tested to withstand heavy storms or to carry heavy snows.

FOR ANY AIRPORT...PRIVATE FIELD...COUNTRY ESTATE

Here is the answer to a flyer's problem . . . a hangar for his plane when he is on the ground . . . a garage for his car when he is in the air. • It's absolutely safe, sturdy, quick and easy to erect, attractive appearance, and so low in cost that commercial operators can afford several.

Careful engineering enables the steel frame hangar to be fully assembled and ready in 5 hours. Only hammer and pliers are necessary. Welded trusses with "U" clips and sockets permit easy assembly. No cutting or fitting necessary. Installation can be either permanent or portable.

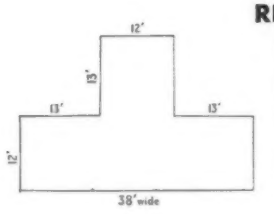
Shipment is simple . . . you receive one bundle of canvas and one bundle of pipe, ready for assembly. Deliveries can be made at this time. We were fortunate in securing a good supply of material . . . but the instant success of this hangar makes it extremely essential that you place your order at once.



Entire frame is welded steel tubing. Main truss section is welded bridge type.

Side walls reinforced to withstand winds of gale velocity. Roll-up door disappears into top of hangar with a 15 lb. pull. No bother with tracks, hinges or swinging doors. Hangar weighs about 1285 lbs. Roof is of 15 oz. canvas reinforced for added strength.

READ THIS . . .



Here is proof of the sturdy construction of a STEEL FRAME HANGAR.

"I thought you might be interested in knowing how your steel frame airplane hangar withstood the unusual wind storm we had here the other day.

"In checking with the weather bureau, I learned the wind reached velocities as high as 75 miles an hour, with strong gusts."

Signed: Ronald Chappell
Chappell Flying Service, Detroit, Michigan

YOUR STEEL FRAME HANGAR WILL PAY FOR ITSELF IN LESS THAN 2 YEARS

SEND $25 DEPOSIT FOR EACH HANGAR ORDERED—FINANCING TERMS CAN BE ARRANGED THROUGH YOUR LOCAL BANK

STEEL FRAME AIRPLANE HANGARS, 10218 W. McNichols Road, Detroit, Mich.

This is my order for_____Steel Frame Hangars.

Company Name_____

My deposit of $_____is enclosed

By_____

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HAS OR WILL BUILD

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★ Samples of numerous Government Approved Relays —Solenoids—Contactors for Gun Switch Handles used by the Air Corps—Ordnance—Signal Corps are available upon request.

Relays by Guardian are standard equipment for Radio Transmission—Turret Controls—Bombing Equipment—Fire Control—on practically every Aviation Control Application. Write

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LARGEST LINE OF RELAYS SERVING AMERICAN INDUSTRY

JANUARY 9 · 10 · 11

WE'RE on the BEAM, MIAMI

Aviation's gala event again beckons America's flying fraternity to another great aeronautical meet in Miami, January 9-10-11.

Join the skylane traffic pushing southward to Miami's Air Races where three days of action, thrills and clock-round entertainment await you.

Be a pilot or passenger in one of the many light plane "flight wings" cruising toward Miami, annual host to America's Air Cavalcade participating in the world's oldest and greatest Air Show.

- Miami-Havana Air Cruise
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BUILDERS OF PB2Y AND PBY LONG-RANGE MULTI-MOTORED SEA PLANES FOR THE U. S. NAVY

. . . A Mere Speck in the Sky!

Your skill as one lone pilot . . . your investment as one lone plane owner . . . means but little to National Defense . . . Your skill multiplied by 180,000* . . . your investment multiplied by 25,000* . . . means the greatest reserve of air strength in the world! As you read these words, AOPA is carrying on your campaign in Washington—to secure Non-Scheduled Flying's rightful role in National Defense . . . to "Keep 'Em All Flying!" By enrolling with this non-profit group—America's only nation-wide organization barred to all but aircraft owners and pilots who have soloed—you are translating the skill of one lone pilot . . . the investment of one lone plane owner . . . into the strength of unified thousands.

C.A.A. report of Sept. 1, 1941; 91,442 licensed civil pilots; 89,839 civil student pilots; 23,496 licensed civil aircraft.

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AIRCRAFT OWNERS AND PILOTS ASSOCIATION
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I want to know how AOPA can assist me in my flying problems and "Keep 'Em ALL Flying!" Please send complete details at once.

☐ Please send "Keep 'Em ALL Flying" windshield sticker. Enclosed find 3c stamp to cover mailing cost.

NAME .....

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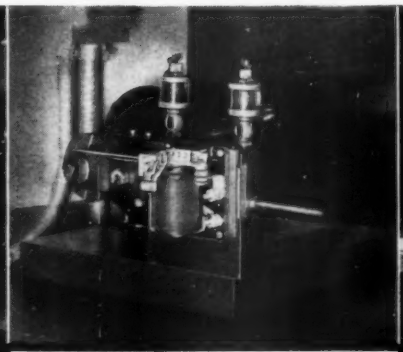
(Sent only to private aircraft owners or pilots who have soloed)

"KEEP 'EM ALL FLYING!"

It's catching on among Non-Scheduled Flyers—AOPA's version of the Army's slogan. Stickers in two colors are available, free of charge, for windshields of pilots who have soloed. Use handy coupon at the left.

DUNCO Gives Aviation Relays These Specific Aviation Tests!

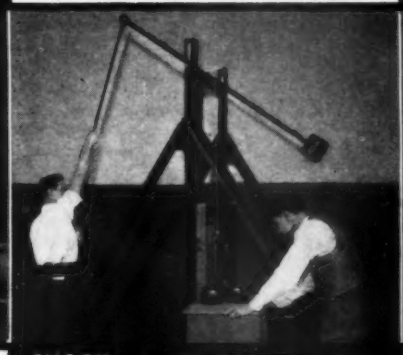
HIGH FREQUENCY . . . An oscillator delivering frequencies from 100 to 1200 cycles supplies sufficient power output for operating relay coil circuits at high frequencies without reducing the applied voltage.



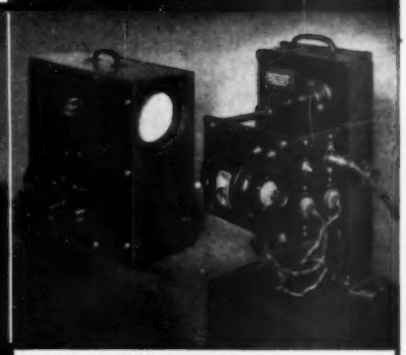
VIBRATION... A vibration testing machine proves the ability of Dunco relays to withstand specified vibration tests. Speeds up to 60 cycles per second at various amplitudes may be obtained with this test equipment.

CURRENT . . . Storage batteries delivering any d-c voltage from 2 to 24 volts provide for strenuous load tests. Inrush currents up to 500 amperes and continuous currents up to 250 amperes at 24 volts are obtainable.

ALTITUDE... A bell jar, vacuum pump and altitude meter for simulating conditions at altitudes as high as 30,000 feet enable a study of contact action under such conditions.



SHOCK . . . A shock testing device covers the exacting Navy requirements in this important test and enables Dunco to study relay performance under abnormal conditions.



HIGH-SPEED TIMING... An oscilloscope and high-speed motion picture camera provide a means of studying high-speed contact action which cannot be seen with the eye.

Dunco relays and solenoids for aviation uses are *not* ordinary stock units such as might be sold for ordinary applications. Each Dunco aviation type has been specifically designed by Dunco engineers working in direct cooperation with leading aircraft and component manufacturers. In addition to the usual material and manufacturing tests, Dunco aviation relays are subjected to the additional specific tests illustrated above. This exclusive and specially designed Dunco aviation test equipment plays an essential part in proving the performance and dependability of these units under aviation's most exacting requirements.

NEW! The DUNCO AVIATION BULLETIN

A copy of the new Dunco Aviation Relay and Solenoid Bulletin No. P-245 will gladly be sent upon request. If desired, we shall also be glad to send a copy of the complete Dunco Catalog and Data Book including relays for a wide variety of requirements.

STRUTHERS DUNN, Inc. • 1336 Cherry Street, Philadelphia, Pa.

The Naval Aircraft Factory

(*Continued from page 131*)

plant accessories.

2. MATERIALS LABORATORY, covering test and development of metals, fabrics, paints, dopes, finishes and preservatives; also numerous accessories and articles of equipment.
3. STRUCTURES LABORATORY, covering the test and development of structures, including vibration tests and static destruction of complete airplane structures.
4. CATAPULT SECTION, covering the design, test and development of all Navy catapults and catapult tests of all experimental and service airplanes.
5. SHIP EXPERIMENTAL UNIT, covering deck landing tests of all experimental and service landplanes and development of arresting devices.
6. DEVELOPMENT OF NAVIGATIONAL INSTRUMENTS. Expansion of this phase of the establishment's work is contemplated in the near future.

It is not the policy of the Bureau of Aeronautics to conduct research in these laboratories, hence development testing is avoided as much as possible. There is, nevertheless, a considerable amount of fundamental information obtained as a by-product of acceptance testing. This information, which has contributed to many important improvements to aircraft and aircraft material, is made available to the aircraft industry.

The production department includes the planning section and the various shops.

Experimental work and manufacture are carried out in the same shops. Due to the multiplicity of the product, the shops are operated as jobbing shops with machine tools grouped by classes, in order that the maximum of expert supervision may be obtained for all operations. Assembly lines are established in the assembly shops, although the chain type, now coming into use by aircraft manufacturers, is not as yet warranted.

The planning office prepares detail schedules for shop work. No job can be scheduled and forgotten. Because of constantly changing conditions, continuous follow-up is maintained by this section, and adjustments are made in schedules to offset, as far as possible, delays occasioned by shortages of material, breakdown of equipment, etc. An enormous amount of detail administrative work is required to operate this system, but it has been found to be the best practical means of keeping work on schedule in the more than 500 separate projects that are under schedule at all times.

The inspection department provides inspection of all incoming material, whether intended for use at the factory or ultimately destined to other stations; of all work in process and final inspection of the product of the factory. It collaborates with the engineering and production departments in the salvage of scrap and rejected parts. In addition, it operates a school for the training of inspectors for the field service of the Bureau of Aeronautics.

The aircraft factory has facilities for the operation of both landplanes and seaplanes. Flight operations are chiefly tests of new planes, and planes incorporating experimental developments.

Other work includes power plant installation, instrument development, and experiments in the many features peculiar to Naval aircraft that are under development in the industry.

The plant department is charged with the maintenance of the factory and grounds. It contains a group of versatile mechanics, representing most of the well-known trades, experienced in the kind of work necessary for the repair and alteration of machine tools, power equipment and buildings. In addition, it operates the factory's steam generating plant and distribution system, transportation system and the janitor service.

There are several features of the aircraft factory that are unique and differentiate it from the general run of aircraft manufacturing plants. It is the only plant that manufactures both airplanes and airplane engines. It combines experimental development work with its manufacturing to a greater extent than is ordinarily found. Also, it goes beyond the confines of the aircraft field, working on the development of equipment for ships that operate aircraft.

At the present time about one-half of the factory's effort is devoted to manufacturing, and the other half to experimental and development work and the other activities of the factory. The manufacture of airplanes and engines at the aircraft factory is intended primarily for the purpose of accumulating cost data to be used by the Navy in establishing fair prices to be paid for contract work. Actually, in the present emergency, the factory has proved to be an important source of supply of training planes for the Navy. A considerable manufacturing capacity could be made immediately available without delay in financing and construction of additional facilities.

The manufacturing work, as carried on at the Naval Aircraft Factory, has another important advantage in that it provides a reservoir of equipment and skilled workers, who are available on short notice to undertake urgent new developments in the furtherance of Naval aviation.

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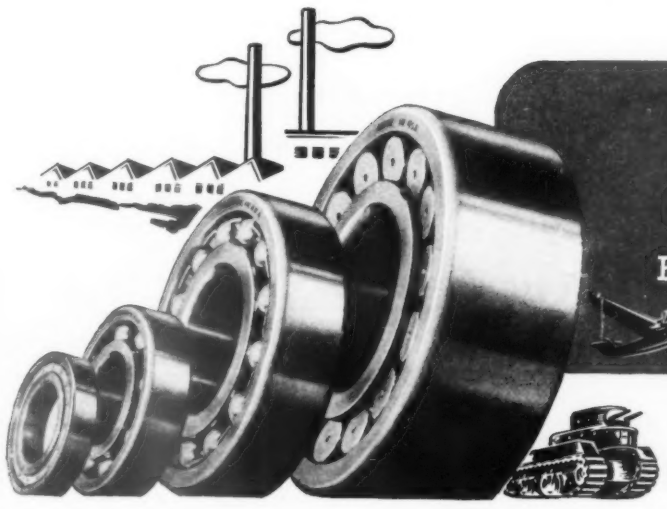

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As this advertisement is being written (appropriately enough on Navy Day) we reflect on our part in the history of aviation

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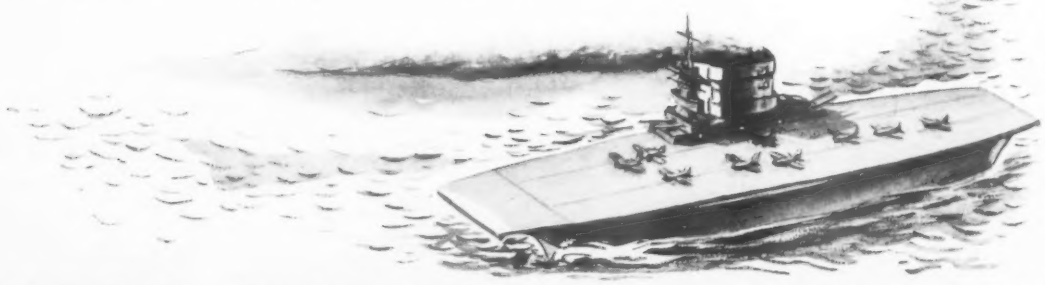

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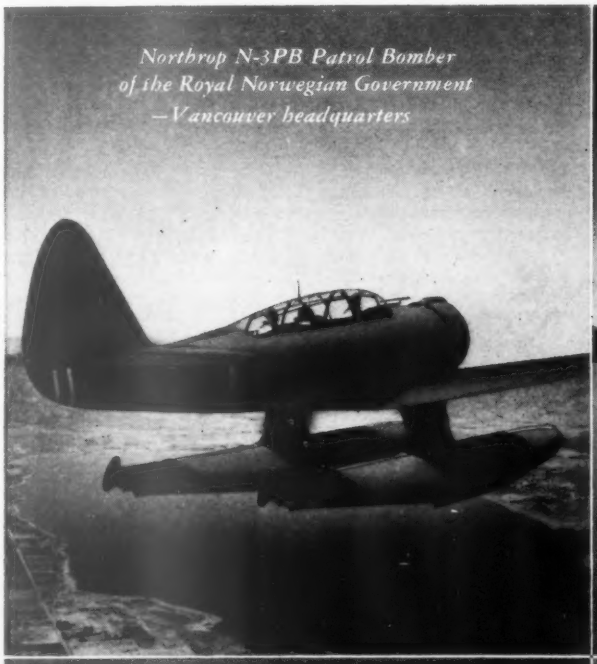
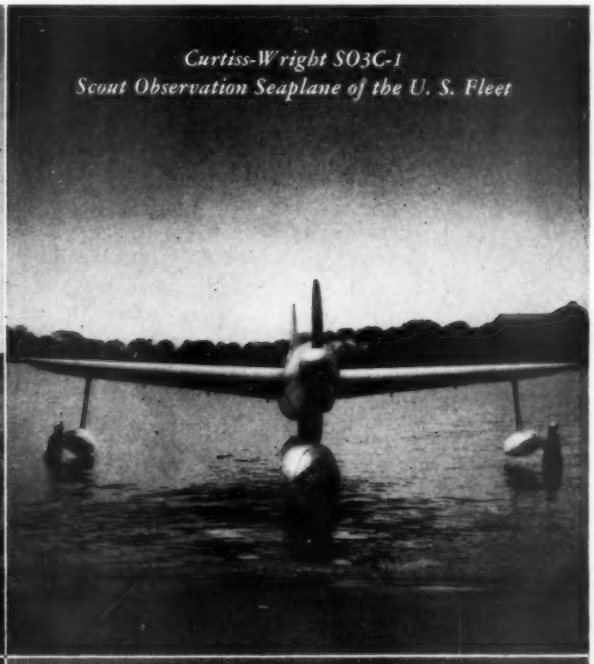


Northrop N-3PB Patrol Bomber of the Royal Norwegian Government —Vancouver headquarters



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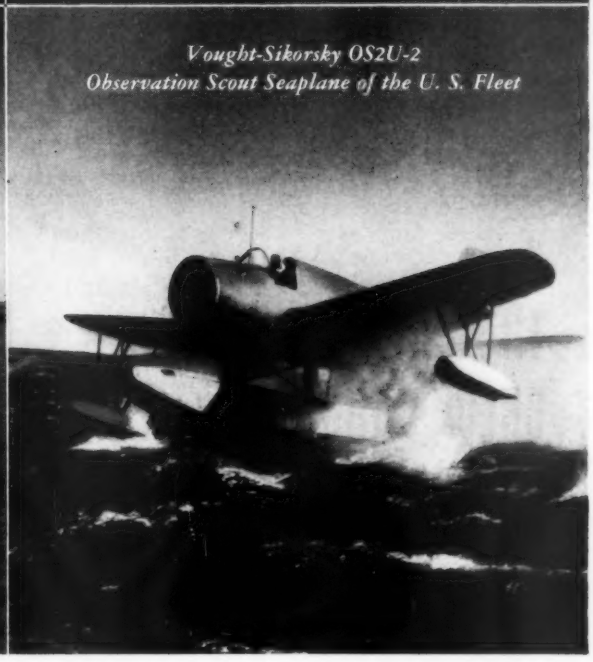

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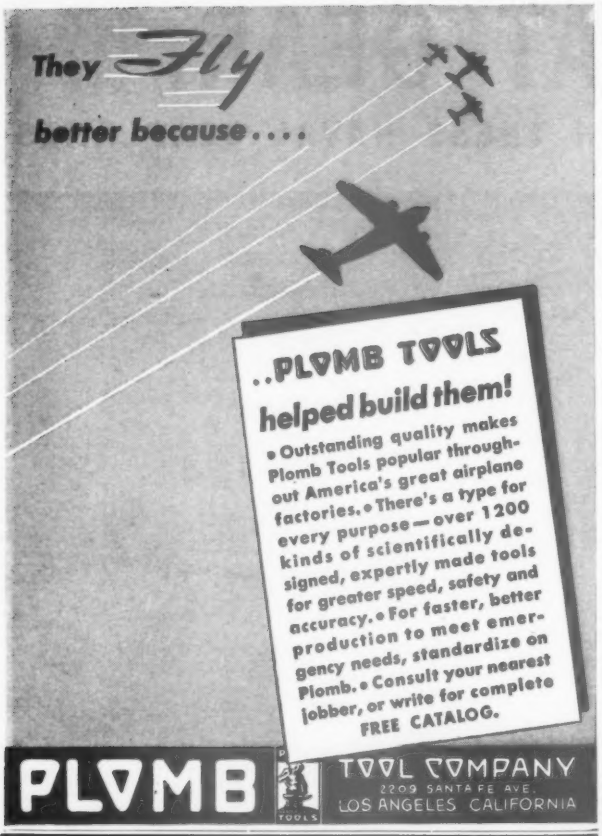
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Training the Naval Aviator

(*Continued from page 84*)

With the two-week indoctrination course and four weeks of the ground school course behind, the cadet reports to one of the four primary training squadrons at either Corry or Saufley Field, both of which, because of their distance from the station proper, are designated as outlying fields. Assigned to an experienced instructor, he spends his first few hours learning the fundamentals of taxiing, taking-off, turning, stalling, spinning, gliding and landing. His preliminary instruction completed, he goes aloft for a solo check.

After passing the solo check, the student advances to steep or "flipper" turns and spirals, precision landings in a circle, small field procedure, aerobatics, formation flying and night flying. Always under the watchful eye of an instructor, he is given additional dual work as time goes on, and is checked frequently to guard against his acquiring bad flying habits. Periodically, check flights are made with other instructors. If the first check is chalked up as a failure, two out of three checks each with a different instructor must then be passed successfully.

Advancing to Squadron 2 at Ellyson Field after passing the final check in Squadron 1, the cadet enters basic training and gets a short course in a heavier plane that serves as a bridge to service-type landplanes. These planes have more powerful engines, and higher take-off and landing speeds. Spending about a third of his time in normal flying, turns and spirals, emergency and precision landings, the remainder of his time is devoted to three-plane section and nine-plane division formation flying.

Upon successful completion of the course at Squadron 2, the next move which looms up is Squadron 3 at Chevalier Field on the main station. Here the cadet sweats blood and tears in the Link Trainer before "flying under the hood" of an instrument flying plane. Supplementing this training of flying on instruments, he is taught the theory of how to solve radio-beam problems.

At this point basic training is completed and the student is ready for the advanced training which may send him to any one of the remaining three squadrons for battleship-cruiser seaplane, patrol boat, or carrier-based landplane training.

If assigned to battleship-cruiser seaplane training in Squadron 5, he starts anew with a primary plane, this time a primary seaplane, Before advancing to heavier and more powerful seaplanes, he must put his seamanship (learned during indoctrination) into practice and master the technique

Numerous ramps at Pensacola are for launching these N3N seaplane trainers. Derricks lift them ashore after day's flying.

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of operating from the water. Next follow familiarization flights and training in navigation, radio communication procedure, spotting, aerial gunnery, bombing, catapult launchings and instrument flying at night.

Should he be assigned to Squadron 4, he learns to fly the big two-engined patrol boats in which he may be called upon to act as radioman, machine gunner, navigator or pilot. Graduates of this course are assigned to one of the land-based patrol squadrons where additional training and experience are obtained in daily operations.

Students selected for carrier duty go to the Naval Air Station, Miami, for a special six-week course in carrier-based land planes. There, over the flat marshlands of the Everglades, they fly scout and observation planes, fast single-seated fighters, dive bombers and torpedo planes in preparation for duty at sea.

On completing any one of the three advanced training courses, pinfeathers are shed for the full-fledged wings, which accompany the designation earned as a Naval aviator, and a commission as an ensign in the Naval reserve or second lieutenant in the Marine Corps reserve.

The varying rates of progress of the cadets make graduations by classes impossible. The designation ceremonies—held three times weekly—are short, during which the commandant impresses on the newly-commissioned officers their responsibilities as aviators and officers.

Following the completion of the course the newly-commissioned officers are given approximately 18 days of leave. Insofar as conditions permit, as many as possible of these men return to Pensacola for additional instruction in the Instructor's School, where they are taught proved methods of aviation instruction. During the training course for aviation cadets quite a number "bust out" and return to their homes. Some fail to meet academic requirements, others fail to pass their various checks, while still others develop disqualifying physical defects, acquire a fear of the air or ask that their training be discontinued for personal reasons. Those who so desire, and who possess qualifications or aptitude for specialized duty, are given the opportunity of qualifying for an A-V(S)—Aviation, Special Service—commission.

In reading the foregoing, the reader may get the impression that Pensacola is all work and no play. Not quite! To keep the cadets physically fit and to provide them with necessary relaxation a well-balanced athletic program has been developed. In addition to 10 minutes of calisthenics in the wee hours of early morning, they indulge in supervised athletics for one hour on Mondays, Tuesdays, and Thursdays of the week. As currently planned, the program includes two weeks of instruction and participation in basketball, swimming, volley-ball, handball, crew, tennis, bowling, golf, jiujitsu and touch football.

The emphasis on all athletics is on balance, rhythm and co-ordination—not muscle building. For this reason, fencing is under consideration as an addition to the athletic program. Boxing, while tolerated, is not encouraged . . . eyes are too important. Those who desire varsity competition may participate in tennis, football, baseball, basketball, sailing or skeet.

The educational, recreational and social sides of cadet life are by no means neglected. In addition to a well-stocked station library, reading rooms with the latest newspapers and magazines are maintained in each of the cadet barracks. The nearby cadet recreation building, in addition to reading material, contains card, ping pong and billiard tables, as well as other recreational facilities.

Another popular recreational feature is the modern air-conditioned theater, which presents two free movies on week days and three on Sundays. The theater also offers two other attractions—mass singing on Sundays and Tuesdays, and a weekly radio broadcast, featuring station talent, on Fridays.

On the convivial side, cadets enjoy the privileges of the officers club and together with their guests constitute the majority of those in attendance at the dances given each Saturday night at Mustin Beach, the station's popular social rendezvous. Generous liberty hours—daily in the case of first-class cadets—enable them to visit Pensacola and points within a 50-mile radius for business and personal calls.

Social activities at Pensacola play an important part in the transformation of the cadet into the Naval officer in that they impress upon him certain service traditions and mores that he can learn in no other manner.

Crammed into the short period of approximately seven months, the training of the Naval aviator is a carefully planned and co-ordinated program which operates with clock-like precision. The products thereof are eager, willing and able youngsters, trained to a knowledge of the Navy's customs, doctrines and missions, who will give a good account of themselves when and if the occasion demands.

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History

(*Continued from page 33*)

immediately following World War I, and the "J" type non-rigid was also produced.

The *Shenandoah*, first American-designed-and-built rigid, was commissioned in October, 1923. Before her destruction in a severe storm in September, 1925, she made many notable flights, contributing greatly to the knowledge and science of this field of aviation.

The *U.S.S. Los Angeles*, built in Germany and delivered to the Navy in October, 1924, for nearly eight years carried out experiments of a wide variety and operated extensively with the Fleet. Two of her most important contributions were the development and test of more efficient ground-handling facilities and development of the hook-on device for airplanes.

In 1928, contracts were let for two new rigid airships—the *U.S.S. Akron* and *U.S.S. Macon*. They were a radical departure, especially in size, from previous rigids, having 6,500,000-cubic feet capacity as compared with the 2,500,000-cubic feet of the *Shenandoah* and *Los Angeles*. Unfortunately, both of these ships were destroyed in 1933-1935, respectively. Only the *U.S.S. Los Angeles* remained, and she, in 1940, at the age of 16 years, was stricken from the Navy's list of ships. In 1940, Congress authorized the building of 48-non-rigids and establishment of additional shore facilities to permit extended lighter-than-air operations. Both projects are now being carried out.

The Vinson-Trammell Bill, signed in 1934, provided for an increase in airplanes commensurate with the increase in combatant surface ships also authorized. An estimate of approximately 1,900 airplanes was drawn up. This normal expansion served as a tremendous impetus in the procurement of types that had been in the minds of experts for years.

The year 1940, with the war in Europe already a year old, saw the end of normal expansion. The President called for 50,000 airplanes. Congress authorized and appropriated millions of dollars for national defense. Strength figures for Naval aircraft were changed almost overnight until on July 19, 1940, the present 15,000-plane program was authorized.

The procurement of 15,000 airplanes was merely one of the elements of the expansion program. The building of the two-ocean Navy, the erection of additional shore facilities and the training of pilots were all scheduled to meet, as nearly as possible, at a common completion point.

Already the Navy has 31 air stations in commission and operating. Additional aviation facilities ashore, for the operation and maintenance of aircraft, are being rushed to completion. The pilot training program has been stepped-up to the point where 800 flight students are admitted each month to the air stations at Pensacola and Miami, Fla., and Corpus Christi, Tex.

Training, equipment, maintenance and organization of Marine Corps aviation has been correlated to make possible its instant service with the Fleet in either defensive or offensive action.

The present recordings of Naval aviation, which tomorrow will be history, are set forth in detail in this issue. Catapults, carriers, airplanes and operations have progressed to the point where only the basic concepts are recognizable.

A new era in Naval aviation history has dawned. No longer is it in a period of innovation. Outstanding individual accomplishments are blended to produce a mighty team motivated by the same basic thought. The men of the Navy in all its branches know how their role, as well as the role of others, must be played if the Navy is to continue to fulfill its prescribed position and if history still is to be written of our first line of defense.

END

Fighter

(*Continued from page 62*)

any adversary and good protection for the pilot and vital parts of the plane.

This sounds like a dream of the millennium, but by prompt molding of all the most recent engineering developments into experimental designs and by properly selecting the necessary compromises it is possible to gain and maintain an advantage over probable enemies which can be a decisive factor in case of war.

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Aviation and the Navy

(*Continued from page 25*)

any such demonstration were necessary, that the air arm was an indispensable part of the Fleet. A Naval force without air support is helpless in action against an enemy possessed of it; amphibious operations without control of the air are doomed to disaster. In every phase of Naval action, aircraft play their increasingly vital part and there is not an officer or man in the United States Navy who is unaware of this fundamental fact.

This pervading importance of aviation in Naval affairs has become so familiar to Naval personnel that they sometimes fail to realize how much of it is unfamiliar to the public. Except for the activity at training centers and at the few coastal stations in the continental United States, little of the Navy's 120,000 hours of flying per month takes place in sight or knowledge of the bulk of our citizenry. Yet, day in, day out, from carriers, battleships and cruisers at sea, and from bases reaching in a tremendous arc from Iceland through Trinidad, Panama and Hawaii to the Bering Sea, Naval aircraft are aloft in defense of the freedom of the seas, and in perfecting themselves for the day when the fate of the nation may depend upon the keen eyes of a Naval aviator searching a broad expanse of ocean for any enemy fleet. Daily, the patrol bombers take off from our outlying bases on patrols that will end only with nightfall; daily, the fighters, scouts and bombers from our carriers are aloft on the never ending missions of training, and to provide security for the ships far below; while from battleships and cruisers observation planes are catapulted into flight, to spot the fall of shot in target practice, to extend the sea areas which they can observe and to drill unceasingly in radio communication with parent ships.

Each task assigned the aircraft of the Fleet demands the development of a type best suited to its accomplishment. The characteristics desired in each type of Naval aircraft are determined after careful consideration of the duties which it must perform and are specified by the General Board of the Navy after consultation with the forces afloat and the design experts in the Bureau of Aeronautics. The characteristics thus determined are then presented to the aviation industry in the form of preliminary specifications, and proposals are invited from them, either in a design competition or as an experimental order. The resultant airplanes are subjected to trials by experienced Naval aviators, and by the pilots who will operate them in the Fleet. From their recommendations emerge the production model of the particular type under consideration, ready for quantity orders and eventual service in the squadrons afloat. The aircraft thus produced are pre-eminently Naval aircraft. They embody features which have developed from years of experience in flying over salt water in the performance of Naval missions. In many important details of equipment, of materials used in their structure and in basic design, they differ greatly from their counterparts in shore-based aviation.

Their pilots, likewise, are *Naval* aviators. Apart from their schooling in airmanship, they have been indoctrinated in their profession of waging war at sea. They are drawn from the same sources, attend the same schools, live in the same ships and eat in the same messes as their brothers of the line of the Navy. Intimate daily association, employment in the common task, brings about a community of thought and interest which insures a community of effort directed toward the attainment of a common objective—the defeat of the enemy by imposing upon him the will of the Commander-in-Chief. They are members of a team, a team whose strength far surpasses the sum of the strengths of its individual players, and it is essential, as it is in football, that they train under the same coach. The tragic spectacle of Italian men-of-war being bombed by Italian aviators who were unable, by reason of their training under another branch of the Italian military forces, to recognize them as friendly ships, is one which we do not wish to see repeated in our own operation. It need not be repeated if Naval aviation continues to be a Naval responsibility, and is allowed to expand on the sound organizational principles which have guided it since its birth.

END

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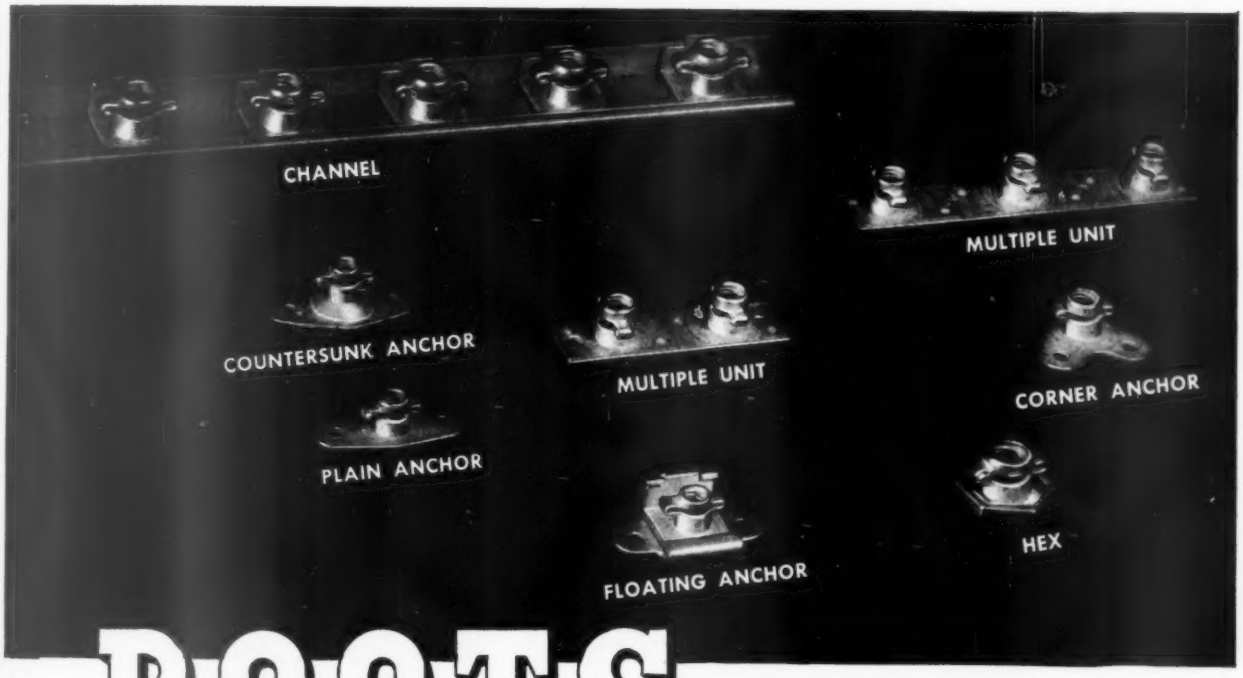

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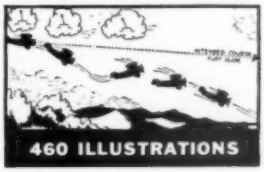

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Experimental

(*Continued from page 146*)

essentials cannot be satisfactorily answered in drawings, a mock-up, or dummy airplane of wood, is built by the contractor. The mock-up is criticized in detail in all aspects of the airplane's functioning by a board of officer and civilian specialists before the final arrangement is crystallized. Then follows the long and careful program of detailed design and structural testing, guided by the Navy to an extent only sufficient to insure results satisfactory for its purposes.

When the experimental airplane is ready for flight, most contracts require that it be first demonstrated by the manufacturer. After successful completion of the demonstration, it is subjected to exhaustive flight tests by the Navy, and the proper functioning of all equipment, including armament, is checked. It is determined whether the airplane is in accordance with the contractor's guarantees both as an appraisal of service usefulness and for purposes of payment. The airplane is catapulted, landed in deck arresting gear, or in rough water, depending on its intended services. These tests are thorough and are not done once but many times, in order that the probable range of service use may be covered.

The airplane is then subjected to an accelerated service test, where a large amount of flying time is accumulated rapidly under varying operating conditions. It is also sent to a service overhaul base for an actual check of the probable ease of keeping it flying. The purpose of all this elaborate testing is to discover any weaknesses or deficiencies. If any are discovered, cures for them are devised, and after the adequacy of the cures is checked they are incorporated in the production model.

Occasionally when an airplane has passed the mock-up stage, where no highly experimental features are involved and the need for a new service model has been sufficiently great, the Navy has felt warranted in placing a production order before the experimental airplane has flown. Even then, the full testing schedule is followed, and, since the experimental airplane is available long before the production airplanes, necessary changes can still be made.

The Navy's test personnel are composed of experienced pilots who are drawn from the service and returned thereto. A similar policy is followed in the Bureau of Aeronautics, which is largely officered by Naval aviators with recent operating experience.

Mock-up boards are composed of such officers who may, however, be specialized on power plants, radio, carrier features or any of the many aspects of aviation material. Civilian engineers and technicians provide a continuing background for the Navy's efforts in experimentation. The commissioned officers are rotated in their duties with operating units, as observers abroad, inspectors at manufacturers' plants, overhaul bases, or other stations which add to their value as Naval aviation officers. Thus, at all stages of a new airplane, from its conception until it finally reaches the service in squadron use, the varying requirements of the manufacturer's production problems, the paramount lessons of the war and, most of all, the operating problems of our own Navy in its particular strategic position, are represented and applied.

It is not at the moment in the public interest to disclose in detail the experimental program that is underway. However, the system in the Navy has been evolved to meet the Navy's peculiar needs. The fact that American Naval aviation, in its material as well as in other aspects, is today definitely known to be in advance of naval aviation in every foreign country in the world, regardless of what air organization that country may have, is a reasonable foundation for the belief that adequate steps have been taken to continue that ascendancy.

Every step of Naval aviation development, from the high performance and heavy striking power of carrier-based fighters and dive bombers, to the long-range flying boats that do service as scouts, to the torpedo carriers or high altitude bombers, has been the result of understanding care and years of hard experimental work. In this respect, the Navy today understands its job better than ever before.

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The Torpedo Plane

(*Continued from page 66*)

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If, as many authorities believe, the day of great sea battles between opposing fleets is past, the torpedo plane has certainly come into its own. A carrier with a squadron or two of these planes on board can range far wider and swifter than a submarine and carry enough materials to sink a hundred merchantmen. As an antidote for the surface raider the carrier-based torpedo plane is hard to beat. At the same time the carrier, the floating base of the squadron with her speed and extensive searching facilities, will be difficult to elude. Against the meager antiaircraft fire of a single surface raider the torpedo plane is almost certain of successful attack. Whatever may be the future developments of this war, so long as control of the sea is in dispute the torpedo plane will find important work to be done.

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Salon Sidelights

OF interest to readers of this issue are the background data on the photographs in the salon section, from pages 99 to 114 inclusive.

"Behind the Flag," on page 99, was taken at Floyd Bennett Field, New York City. The airplanes in the picture are Curtiss SBC-4's (foreground) and Navy-built N3N primary trainers. Floyd Bennett Field is essentially a Naval Reserve aviation base.

The Navy N3N's, shown flying over New York City ("In Training," page 100) also are based at Floyd Bennett Field.

The airplane named "Eye of the Fleet" on page 101 is a Curtiss SOC scout observation biplane, still widely used as a catapult plane aboard battleships and cruisers.

"Tower Control," on page 102, was taken inside the ultra-modern control tower at the huge Naval air station, Norfolk, Va. Planes on the concrete apron, seen through the tower's windows, are (left to right) a North American SNJ, Grumman J2F, Douglas *Dauntless* and an experimental Consolidated PBY-5A with tricycle gear.

In a Norfolk hangar, featured in "Under Cover" on page 103, are two Grumman J2F utility planes.

The "Courier" on page 104 is a North American SNJ, used by Marine flyers for administrative travel. The group shown in "On Parade" includes, from left to right, a Grumman *Wildcat*, Douglas *Devastator*, Vought-Sikorsky *Vindicator* and a Curtiss SBC-4. The camera plane was a North American SNJ.

Grumman JRF's are the subject of "Sea Patrol" on page 105. The striking photograph of aircraft welders on the same page was taken at the Pensacola, Fla., Naval Air Station.

Photographed at the Navy's big lighter-than-air base at Lakehurst, N. J., the airship featured in "Blimp Patrol" on page 106 is the non-rigid K-2.

The striking close-up of the new Curtiss *Helldiver* (SB2C) on page 107 was taken on a photographic flight over Buffalo, N. Y., recently. To get this unusual picture, the camera plane was flown to within a few feet of the subject.

"Beached," on page 107, shows a Consolidated *Catalina* being pulled ashore at the Norfolk air station after a routine flight over the Atlantic.

Brewster *Buffaloes* are shown approaching for a landing over the nose of a *Catalina* in "Aerial Defenders" on page 108.

The largest patrol bomber now in quantity production for the Navy is the Consolidated *Coronado* on page 109. The four-engined giant was photographed while flying in the vicinity of San Diego, Cal.

The *U.S.S. Ranger* served as the photographic subject in "Bird's Nest" on page 110. Planes recognizable on her flight deck include Grumman *Wildcats* (foreground) and Vought-Sikorsky *Vindicators*, with wings folded.

"Transport," on page 111, has as its

(*Continued on page 232*)

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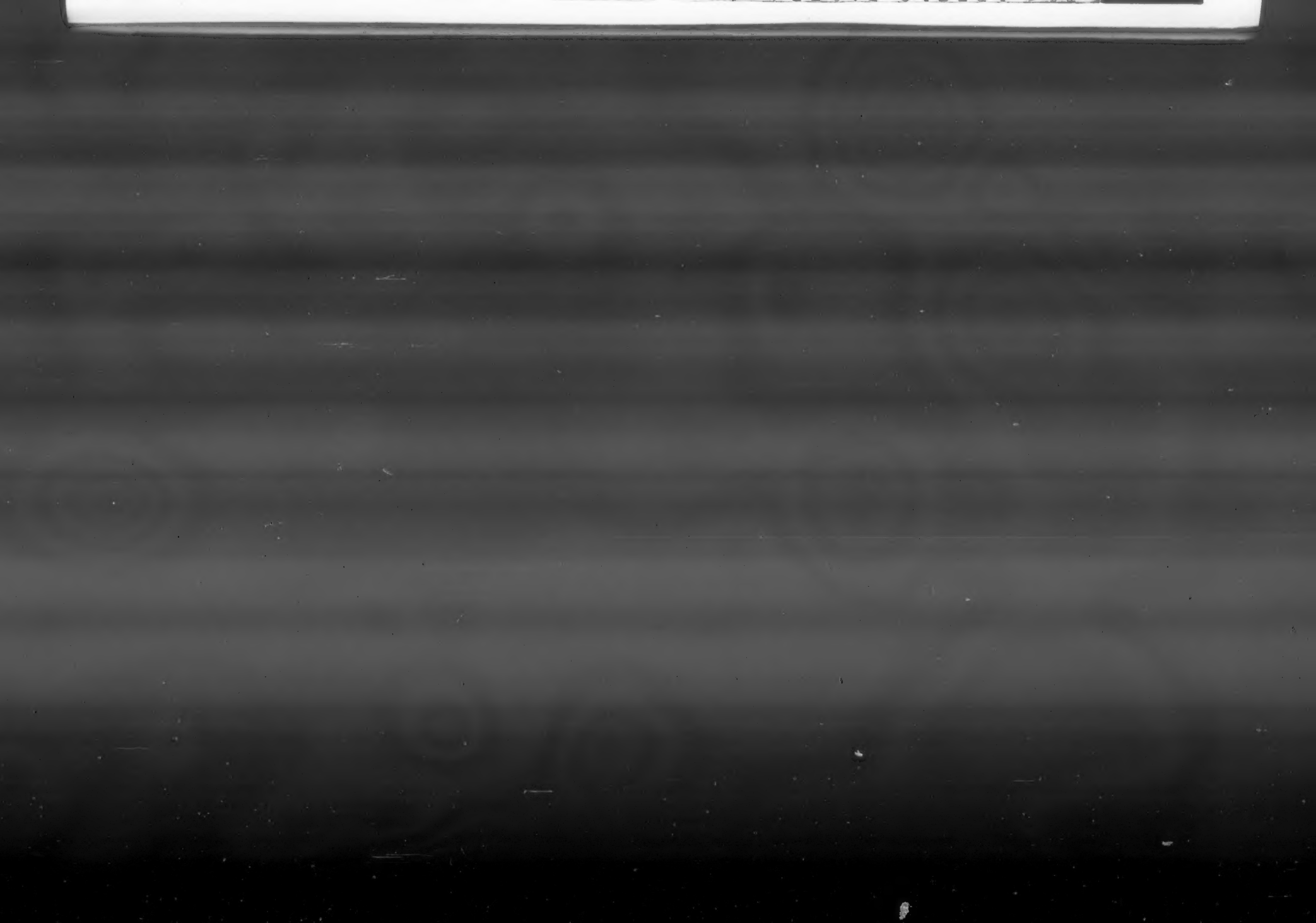

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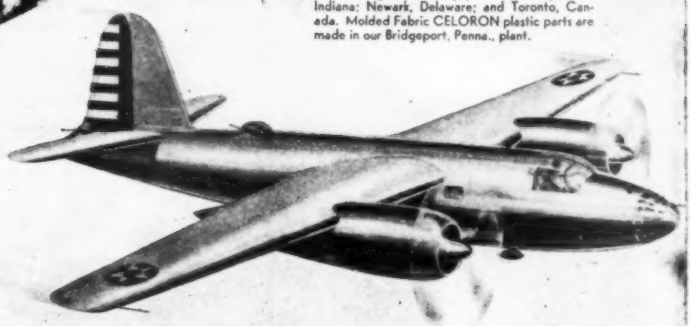

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A vice admiral and rear admiral (upper half of Navy List) draw the same pay as a full admiral with the extra 50 per cent for flying duty. A rear admiral (lower half) receives a base pay of $6,000 and $40 less on rental allowances. His total yearly salary, if a flying officer, is $10,838.

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"Kollsman," I said and he nodded.

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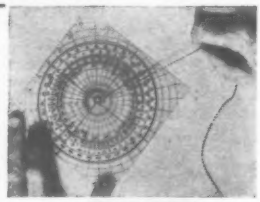

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Salon Sidelights

(*Continued from page 226*)

subject a Marine Beechcraft JRB transport, also used as a photographic plane. The "Leatherneck," on the same page, was taken of a Marine sergeant-pilot climbing into a North American SNJ at Quantico, Va.

The Grumman J2F "On Reconnaissance" on page 112 is from Utility Squadron Four. Note photographer at work in rear cockpit. The Grumman *Wildcats* on the same page were photographed at Norfolk.

Also photographed during a patrol flight out of Norfolk was the Martin *Mariner* on page 113. The mechanic in "Engine Service," on the same page, nonchalantly hung his white service cap on the radio mast while checking the engine of a Sikorsky JRS amphibian.

The striking aerial photograph titled "Roost," on page 114, shows the *U.S.S. Ranger* anchored off New York. Planes on the deck are Vought-Sikorsky SBU's and Grumman F3F's.

END

New Plane Names

THROUGHOUT this special issue of FLYING AND POPULAR AVIATION at the request of the Navy Department, readers are introduced to the fighting planes of the Navy by their new names. It is the first time that any aviation publication has presented a complete report of the new identification system which went into effect October 1 by order of the Secretary of the Navy.

Colorful titles such as *Wildcat, Kingfisher* and *Corsair* have been adopted to supplant the letter-numeral designations that previously were used to classify and designate Naval aircraft. The Navy has made it clear, however, that the old designations still remain in force and unchanged for all official correspondence and dispatches. But to the general public Navy aviation has taken on some names that have a belligerent ring.

They are used throughout this issue and are listed below for quick reference:

Grumman F4F	*Wildcat*
Brewster F2A	*Buffalo*
Vought-Sikorsky F4U	*Corsair*
Consolidated PBY	*Catalina*
Martin PBM	*Mariner*
Martin XPB2M	*Mars*
Consolidated PB2Y	*Coronado*
Boeing PBB	*Sea Ranger*
Douglas TBD	*Devastator*
Grumman TBF	*Avenger*
Brewster SB2A	*Buccaneer*
Curtiss SB2C	*Helldiver*
Douglas SBD	*Dauntless*
Vought-Sikorsky SB2U	*Vindicator*
Curtiss SO3C	*Seagull*
Vought-Sikorsky OS2U	*Kingfisher*

NOTICE TO READERS

All regular departments not appearing in this issue will be reinstated in the February issue.—Ed.

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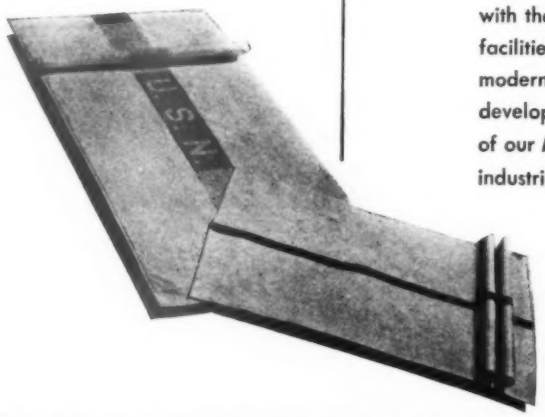

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Seaplane

IT'S REALLY too bad nature didn't equip flying fish with propellers. For getting into the air is really no problem to them at all. They have the power to leap from the water at high speed, taxi along on their rapidly vibrating tails for several yards and readily "take off." But, lacking the means of aerial propulsion, their flights can last but a few seconds.

With man-made "flying fish," however, the situation is reversed. Once in the air, the seaplane leaves its most difficult problem behind. That's the matter of getting several tons of plane, gasoline, passengers, mail and freight "onto the step" and eventually into the air. And the bigger and heavier the ship, the more *power* the engines must have to break the tremendous drag of the water on the hull.

Thus much of the amazing development of the flying boat—as well as other aircraft—in recent years can be credited to improvements in engines and fuels. And it is to help in the continuation of this progress that Ethyl engineers cooperate with aviation engineers in a program of continuous research. Already a fund of useful technical data has been developed. Much of this information has already been applied. A great deal more will undoubtedly be of use in the future. All of it is important to aviation technologists who are seeking greater power for tomorrow's greater planes.

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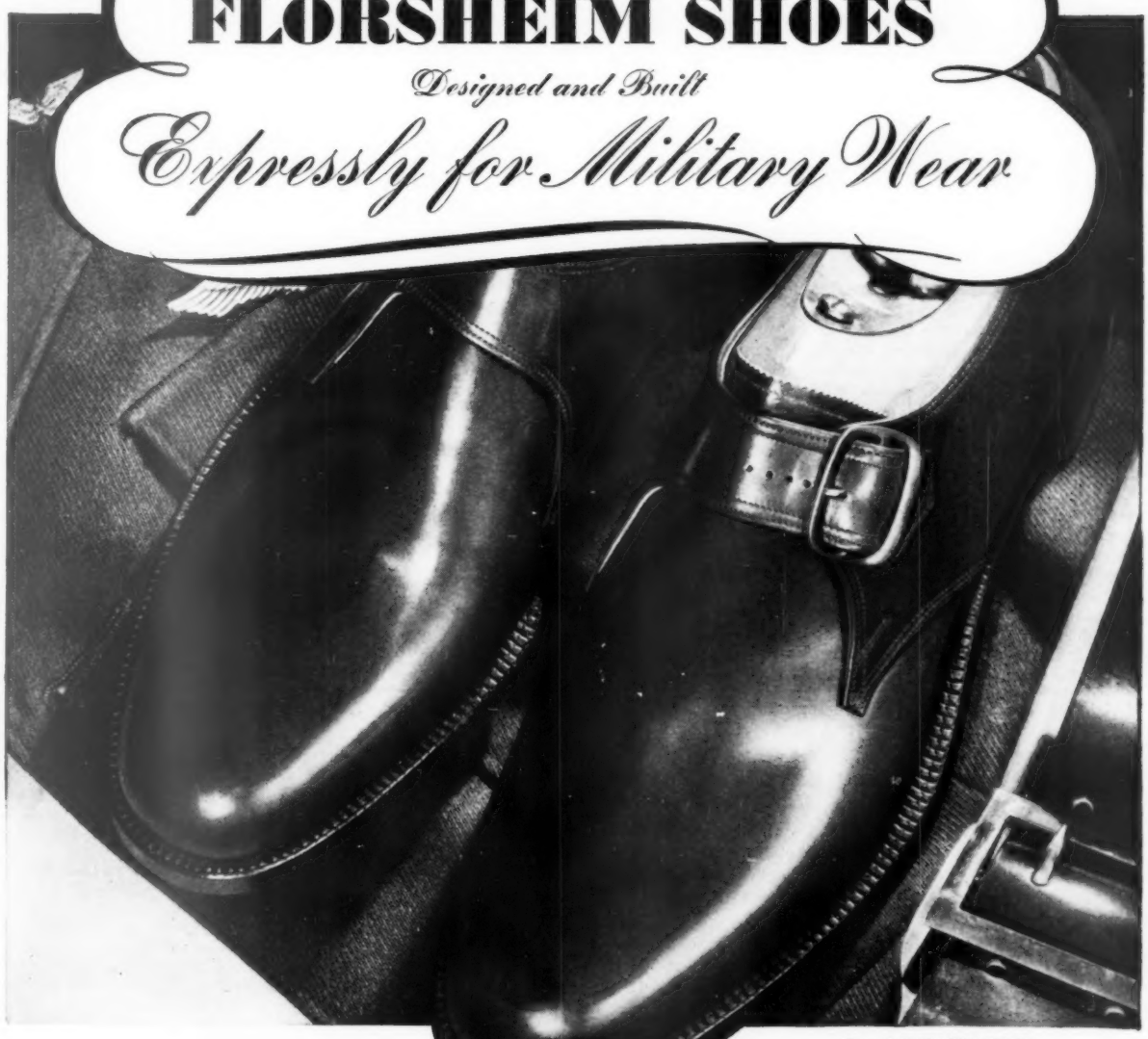

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Power Plants

(*Continued from page 200*)

ard due to the less volatile diesel fuel oil makes the design very desirable for shipboard use.

The problem of the power plant engineer at one time was regarded as comparatively simple by the airplane designer. He merely asked that his next engine produce more power to a higher altitude, have a smaller frontal area with less weight, and use less fuel; while the operator and pilot merely requested that the engine have greater reliability, last longer between overhauls and that it require little or, better still, no attention in flight. Various arrangements of the cylinders have been made or are under development to reduce the frontal area of the engine. Of these, the most successful are the standard vee type engine in an inverted form as built by Fairchild with air-cooled cylinders or some combination of opposed cylinders as used by Lycoming and others.

To visualize properly the results obtained through the 40 years of airplane operation one must compare the compact dependable engine of today with the low powered, heavy engine used by the Wright Brothers in their memorable flight at Kitty Hawk in 1903. This early airplane engine was a four-cylinder model which developed some 30 odd h.p. with a weight of approximately 180 pounds, a weight power ratio of six to one. The service engines of today normally develop 1,000- to 2,500-odd h.p. at a weight of slightly over one pound per h.p. and their dependability is such that a service operating period of 500 hours and more between overhauls, is routine.

The co-operation between the Army Air Corps, the Navy, the National Advisory Committee for Aeronautics and other Government laboratories is responsible for many advances in aeronautics. This co-operation has taken various forms. Joint Army-Navy investigations, the whirl testing of propellers by the Air Corps, joint support of research problems and particularly the standardization of parts and accessories, makes the present stupendous mass production of engines possible.

Whenever it has been possible to get more accurate information for test or research problems by the use of other Government agencies or facilities, they have been utilized. It has been found that they have been eager to volunteer and assist. This has been particularly true of the Bureau of Standards in the field of temperature measurements, electric ignition devices, metallurgical problems and other allied fields.

Naval aircraft, large and small, are the eyes of the Fleet and as such must be able to accompany the Fleet anywhere in any weather. The patrol planes have grown from a point where two 400 h.p. Liberty engines could handle them to the present point where four 2,000 h.p. engines are regarded as merely a step in the right direction.

The question of where to stop in the development of high powers is one which seemingly can be answered only by the propeller engineer. He, however, does not believe the end is yet in sight. The three blade, four blade and contra rotating propeller can answer some of the questions. Although the bigger and better engine may be coming, it is always possible, if necessary, to place a few more of the present sizes along the wings. If greater powers are required, you can be quite sure that American ingenuity will do the job.

END

Flying Admirals

THE Fleet air units have one full admiral, two vice admirals and eight rear admirals among their officer personnel.

Although not connected directly with any air unit, Adm. Ernest J. King, commander-in-chief of the Atlantic Fleet, is a qualified Naval aviator. He is the only full admiral holding this rating. The two vice admirals are Charles Adams Blakely, and William Frederick Halsey, Jr. The eight rear admirals are: A. L. Bristol, Leigh Noyes, John Henry Towers, Aubrey Wray Fitch, John Sidney McCain, John Howard Hoover, Ernest Doyle McWhorter and Patrick Neison Lynch Bellinger. Rear Admiral Towers, who is chief of the Bureau of Aeronautics in Washington, D. C., is Naval Aviator No. 1.

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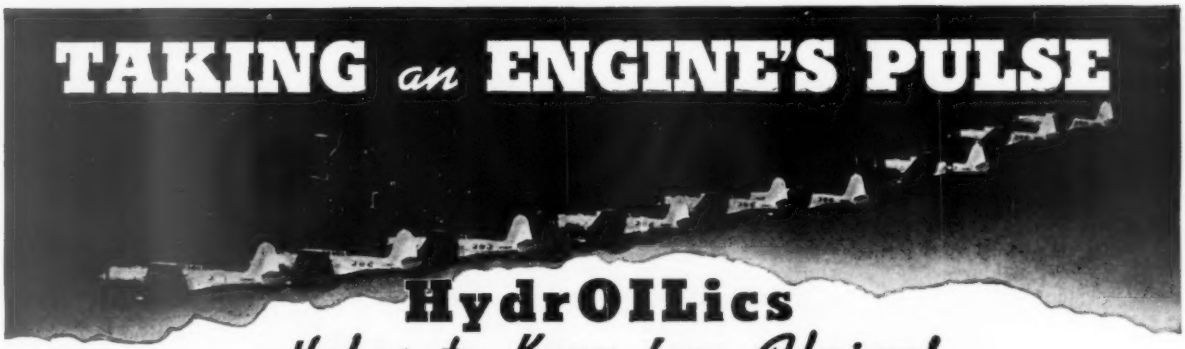

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Armament

(*Continued from page* 138)

Much has been heard about the role played by the carrier-based torpedo bombers in this war. The British successes in the actions at Taranto and Matapan and in the *Bismarck* affair convinced many "doubting Thomases" of the effectiveness of the aircraft torpedo, but this weapon has not always been as highly regarded as it is now. Both in the British and our own Navy, service opinion of aircraft torpedoes, as compared to bombs, has risen and fallen during the last decade like a sine curve, but the value of the torpedo bomber as a type has never been seriously challenged. The controversy has revolved around the question of which weapon was primary. Either bombs, or a torpedo, not both, can be carried.

We generally regard the bomb as the primary offensive weapon of carrier-based planes, while the British favor the torpedo. Such factors as the prevalence of low visibility weather conditions around the British Isles may have bearing on this divergence of views, but the real reason for the difference is believed to lie in the superiority of our bombsight.

More than 20 years ago, the Navy realized that the construction of a precision bombsight was not a mere matter of mechanical gadgeteering. A complete solution of the problem was complex in the extreme, and therefore it would require an intricate and expensive mechanism to solve it. Development along entirely new lines was started, the Navy working with a group of ingenious civilian mathematicians and mechanics—designing, building, testing, improving, year after year—until the present sight was perfected. The Navy's bombsight is now the number one sight of both the Army and the Navy. *It is the greatest single factor of superiority of our air forces over those of the rest of the world.*

Because we have a precision bombsight, *we can make hits* with bombs from altitudes beyond the effective reach of antiaircraft batteries, and so high that it will be difficult for opposing fighters to intercept on short notice.

Marine armament technicians are shown here checking flexible .30 caliber aircraft machine guns after practice at Floyd Bennett Field, N. Y. Tubular devices on barrel ends are flash hiders.

Our carrier-based torpedo bombers carry a larger torpedo or a greater bomb load than any corresponding foreign type. They have better gun protection and yet they are substantially superior in performance factors of speed, range and ceiling. A salvo from a formation of these planes will be difficult to avoid and destructive in its effect.

There remains the patrol bomber which carries more arma-

(*Continued on page* 242)

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P. A. January, 1942

(Continued from page 238)

ment than all the other types put together. Being relatively slow, too big to dodge about much and usually operating singly, it is necessary that this type be given the strongest possible gun defense. Therefore, the Navy starts with the premise that there must be no blind angles from which a hostile fighter can fire without being fired upon in return. Gun stations are located so that the heaviest fire is concentrated in those rear areas from which attacks are most likely to come. It is desirable to make provision for covering any single portion of the rear cone with three different gun stations so that as many as three fighters attacking from the same general direction can be brought under fire simultaneously. Furthermore, such an arrangement is adequate insurance against a bomber being left helplessly to the mercy of its attackers as the result of a lucky shot killing one gunner or disabling his gun mount.

The Navy has a special problem in designing bomb installations for flying boats. Since it is uneconomical to build watertight bomb doors in the bottom, we cannot carry bombs in a manner similar to the conventional fuselage bomb stowage of the landplane bombers. Bombs must go out into the wings. Fortunately wings have grown in thickness and span, which provides room for large numbers of bombs in internal wing compartments. Release systems are greatly complicated by the necessity of providing complete flexibility in selecting the composition and pattern of the bomb salvo to be released. An American bombsight operator faces an array of controls as imposing as the multiple keyboards of a great organ, and his fingers play a funeral dirge for the unfortunate ship in his sight.

It is sometimes said that research and development stop when a war begins. Nothing could be farther from the truth. This is a scientists' war. Research work and new development in aircraft armament for the Navy have been greatly accelerated since the outbreak of the present European conflict, and the best brains in the country are being called in to help.

The interest of the general public in the subject has been tremendously stimulated, as evidenced by the flood of suggestions being received from amateur and professional inventors the country over. Probably no phase of military activity has such a broad popular appeal. By far the greatest portion of these "inventions" have previously been considered or tried and discarded. Many concern devices or weapons which we should like to carry but cannot because of weight limitations. Some are bizarre; for example the flying bomb steered into the target by the reactions of a trained cat encaged in the nose, or the jockey bomb which was to be ridden by a bluejacket who, after shaping the trajectory so as to insure a hit on the enemy battleship, would detach himself at the last moment and "glide in his parachute to a convenient beach."

Every proposal is carefully reviewed, however. About each suggested device we must decide: "Does it pay its freight?" and "Is it better, pound for pound, than what we already have?" Occasionally one is submitted which is novel and has real merit. When this is the case the idea is developed and used and the inventor has performed a patriotic service for his country.

The Defense Air Program has resulted in many improvements in the armament of Naval aircraft and, if we are not too presumptuous in saying so, has also been instrumental in increasing the effectiveness of the armament of British aircraft. It has brought together the armament representatives of the Army Air Corps, the British Royal Air Force and the U. S. Navy in a free exchange of ideas, information and material.

Out of this close liaison has come a program of standardization of equipment wherever practicable—the adopting for use by all three services the best items of armament material possessed by any one of the three. Thus not only is it made possible for each service to have the best equipment available here or in the British Empire, but also the greatest possible economy is insured in the production effort of our industry through a reduction in the number of different items of material required to be manufactured.

Aircraft armament is a fast moving fascinating game, not a game for one who seeks an even tenor in his duties. Changes must be rapid and often radical in order to apply each new lesson of the war. New tactics may require new armament and, conversely, a new weapon might well dictate a major change in the strategy and tactics of the air. The closest liaison is necessary between those responsible for the specification and installation of aircraft armament and the operating personnel in the squadrons who use it.

Intensive research in the laboratories of the Government and private industry cannot be overemphasized. All research findings must be correlated and the new information applied to advance designs that have been specially adapted to meet the Navy's operating needs.

The research work already mentioned is constantly going forward to keep ahead of current development. No opportunity can go unheeded. A very small margin of superiority in material or technique may spell the difference between victory or defeat.

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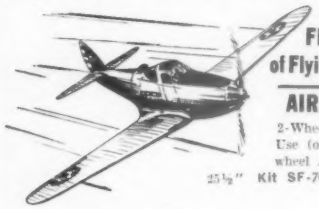

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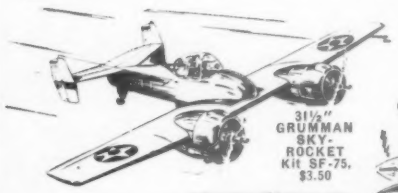

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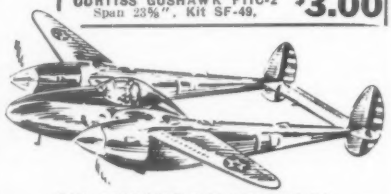

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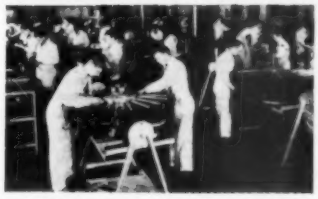

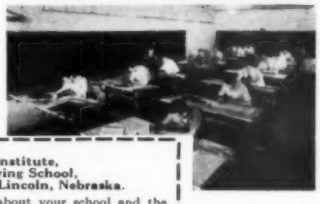

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The Marines

(*Continued from page 90*)

tem of constant training of Marines, plus a policy of the transfer of the individual marine from one post to another every two years, enables the Marine Corps to maintain a highly trained body of men with which it can quickly augment its field fighting units in the Fleet Marine Force, in the event of a national emergency.

The Marine Corps obtains its officers from graduates of the United States Naval Academy, from graduates of leading institutions of learning in all parts of the country through competitive appointment, and from outstanding enlisted men who, after competitive selection, pass an examination showing academic training equivalent to a college curriculum. On receiving a commission the young Marine officer is sent direct to the Basic School at Philadelphia for one year's course, before being assigned to regular duty. A few years later, while still a lieutenant, or junior captain, he is sent either to the Marine Base Defense Weapons School, the company officers' school maintained by the Marine Corps, or to the corresponding Army Infantry School. A large per cent of officers are also sent to the other Army branch service schools at this time, where they specialize in artillery, aviation, chemical warfare, engineering, motor transport and signal communications, every effort being made to keep officers alert and up-to-date in the latest teachings in military science. Marine aviators receive their basic training in aviation at the Naval Air School at Pensacola, Fla.

Just before, or on reaching the rank of Major, all officers are sent to the Marine Corps school for field officers, where they study the tactics of units as large as the war strength Fleet Marine Force, with special emphasis on the landing operations of such a force. A select number of officers are also sent to the Army Command and General Staff School for special training in staff duties and in the tactics of larger units. A few years after completing the above courses, officers are sent to the Naval or Army War Colleges so as to obtain a broader view of Naval and military tactics, and the role of the Marine Corps in the national defense plans.

Enlisted men of the Corps may specialize to a degree in any of the military branches and, in addition, may enter the administrative and supply branches of the Corps. In addition to the above technical schools, the Marine Corps Institute furnishes correspondence courses covering practically every educational subject. The opportunity to take these courses and improve oneself either for higher rank in the Marine Corps or to become better fitted for a place in civil life, is offered free to every Marine. The prerequisite for promotion to any grade is the passage of examinations relative to the duties of that grade. The rank of warrant officer is open to every man enlisting in the Marine Corps, those who have demonstrated their ability through long and outstanding service being selected for this rank.

As a first reservoir of supply for manpower in time of war or national emergency, the Marine Corps maintains an organized reserve. This reserve is divided into the Fleet Marine Corps Reserve, the Organized Marine Corps Reserve, and the Volunteer Marine Corps Reserve. The Organized Marine Corps Reserve comprises 18 infantry battalions, one artillery battalion, and 12 aviation squadrons, located in the larger cities throughout the country. These reserve units, organized and active, are required to engage in weekly drills and undergo an intensive period of field training annually. The drills are held under the direct supervision of Marine Corps officers and enlisted men in the regular service, the active command being exercised by the reserve officers of the units themselves.

The Fleet Marine Corps Reserve comprises officers and enlisted men now in an inactive status who have previously served with the regular Naval or military forces. The Volunteer Marine Corps Reserve comprises officers and enlisted men also in an inactive status who have had previous military experience. All Reservists are available for active duty in time of war or national emergency.

The U. S. Marine Corps is an active military organization, furnishing guards for the shore establishments of the Navy; organized into military units to further our national policy abroad in time of peace under Naval direction; maintaining detachments which play an important role in the combatant ships; and in the Fleet Marine Force, maintaining a well-trained, well-balanced military organization which is ready on an instant's notice to perform its duties as an integral part of the United States Fleet.

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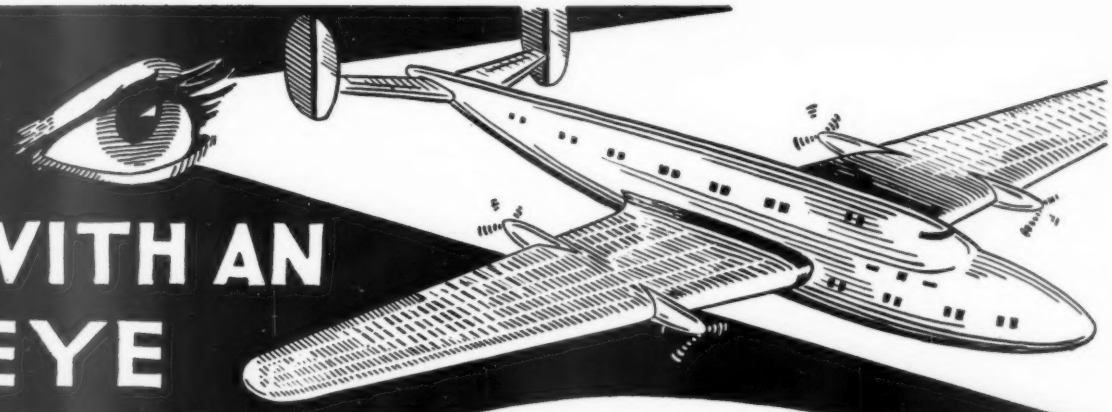

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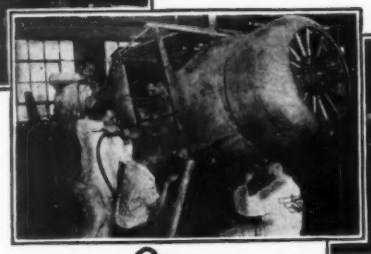

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VJ—The Utility Plane

(*Continued from page 78*)

In another instance, a call came in for the ready plane to go to the scene of a water crash. In 25 minutes the two injured pilots were in an ambulance on the way to the sick bay. In this case, had a plane not been available, no less than two hours could have elapsed in the rescue by using regular surface craft.

In addition to actual rescue work utility planes are often detailed on general humanitarian missions. An instance of this nature occurred last year when the Naval Air Station at Norfolk, Va., received an emergency call to fly medical and food supplies to a small, eight crew cargo boat marooned in 18 inches of ice in the Chesapeake Bay. Delivery was made by packing the supplies in a parachute bag, wrapped in kapok to absorb landing shock. The next day five additional planes flew over the little ship and dropped supplies enough to last until an ice breaker could free her.

The idea of "service" so aptly applies to the Utility Wing that the insignia of the VJ-2 squadron is a three-cornered diaper with the necessary safety pin. No one can deny that the underlying symbolism of this combination unquestionably is "service."

The divergent demands made on the utility plane require a variety of types to meet these tasks. For towing of large target sleeves, either the Consolidated patrol type PBY or the Sikorsky twin-engined amphibian JRS is used. For towing the smaller target sleeves the Grumman single-engined amphibian JF is used.

Photographic work is done with the Grumman twin-engined JRF or the JF and JRS types. Each of these planes is fitted with special hatches in the bottom of the plane so that vertical photographs can be taken. All of the above types are fitted with oblique photographs. For mail or ambulance duty any one of the planes can be used, depending on the amount of mail or the nature of the ambulance case.

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Photography

(Continued from page 149)

use with these cameras, the standard automatic roll developing outfits are furnished to each laboratory.

In addition to the normal oblique and vertical photography, these cameras are used in conjunction with portable flight laboratories which may be carried in any two seater or larger airplane in use in the Navy. With these laboratories it is possible to develop and print film in flight and with the use of special containers, drop the finished print aboard any ship desired.

The Navy is also well equipped with motion picture cameras. As early as 1922 the possible utilization of slow-motion pictures was realized. Even in those days things moved too fast for the human eye to record what was happening in the primitive arresting gear installed on the *U.S.S. Langley*, the Navy's first aircraft carrier. Fortunately the slow-motion camera was available to record the number one landing on the *U.S.S. Langley*, a crowning achievement for a determined group of pioneers and now considered a historical milestone in the development of Naval aviation.

Commencing with this early date, the slow-motion camera has been present for every operation on all carriers. Practically every analysis of failures during carrier operations has been made possible by slow-motion pictures. It is safe to say that the precision now attained in the U. S. Navy carrier work could not have reached the highly efficient stage it now enjoys without benefit of these pictures.

The photographers who operate these complicated motion picture cameras have become so proficient in diagnosing the qualities of an aircraft landing that it has become an axiom in carrier operations that if a pilot, in making his approach to a landing, sees the motion picture operator start grinding out film, he had better prepare for a crash landing.

In addition to the standard commercial high speed 35 mm. motion picture cameras, Naval photographers effectively use various types of 16 mm. motion picture cameras. These cameras are employed primarily for recording tests and experiments and for providing public relations and the press with photographs. In addition, with the wide expansion that is taking place in the Navy, photographers are making all types of motion picture training films.

Laboratory equipment and ground cameras used are the most modern and up-to-date available. In each laboratory there will be found the standard speed graphic, the Graflex, view cameras, copy cameras and all the standard contact printers and enlargers. In addition to this normal laboratory equipment, there are many special pieces not found in the average laboratory.

Four service photographic schools are maintained through the co-operation of the Bureau of Navigation. One for basic photography, one for advanced color, one for slide film and the other for photo interpretation.

Mounted in the bottom of either transport or photographic plane, this type mapping camera will take vertical, overlapping shots.

In addition to the above, the March of Time and the Fairchild Aviation Corporation conduct schools for Naval personnel at no cost to the Government. The March of Time's school is a six-months' course in motion picture work and the present class consists of 20 Navy enlisted men. The Fairchild school is a six-weeks' course in camera repair. The numbers attending this school vary with the availability of personnel.

Personnel for the School of Basic Photography are selected from enlisted men and officers of the regular and reserve Navy. They are sent to the photographic school at Pensacola for a period of four months, studying all phases of basic, ground and aerial photography.

The School of Color Photography is also maintained at the Naval Air Station, Pensacola, and consists of a three-months' course in all phases of this subject. The principles of color photography are taught, utilizing this information by practice with Kodachrome and Dufay film, three-shot color and one-shot color, employing several methods of making prints. Candidates to this school are selected from outstanding photographers within the Fleet.

The Slide Film School is maintained in the Navy Department

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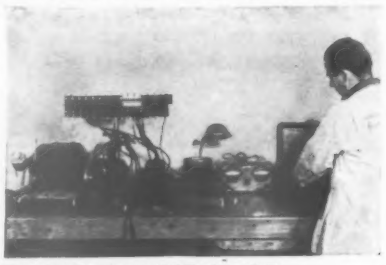
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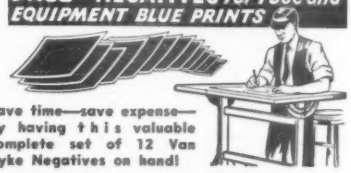
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at Washington, D. C. Candidates attending this school are taught all the necessary rules for making slide films. This, too, is a three-months' course. Candidates to this school are selected from the outstanding photographers graduating from the basic course.

It is essential that the Navy have competent personnel, trained in the interpretation and uses of aerial photography. When procured, this personnel is assigned to force commanders, flight commanders, beach reconnaissance units, Marine Corps units and other major units where the making of aerial photographs is possible.

Every nation at war in Europe employs aerial photographs to the fullest extent in connection with tactical decisions. In many cases these decisions are based exclusively on information obtained from the aerial photographs.

Realizing that the U. S. Navy must be prepared, not only to make similar aerial photographs but to use them intelligently, effectively, thoroughly and to a greater advantage than any potential enemy, a school for the interpretation of aerial photographs has been established at the Naval Air Station, Anacostia, D. C.

With so much stress placed on the importance of aerial photographs, the question may naturally arise, "How are they taken?" During peacetime oblique photographs are made from the average two-seater or multi-place airplane, either open cockpit or cabin design. Vertical photographs are taken from airplanes incorporating especially designed openings in the bottom of the fuselage. Photographers operating the cameras may obtain any desired scale by the proper selection of focal lengths and altitudes flown. However, in the present war, the element of altitude selection is not usually optional. Antiaircraft fire is too accurate and effective to permit low-altitude flying for photographic purposes. Fighter aircraft are too fast and too deadly to permit higher altitude photography by slow moving photographic planes. These factors have caused a radical change in photographic reconnaissance. Multiple cameras are now installed, both for vertical and oblique photography, in fast moving fighter aircraft which are stripped of everything except gasoline and cameras and can outfly any other plane in the air. The pilot is the photographer. Exposures desired are pre-set on the ground and the pilot, by remote control takes the exposures with modern electrically operated cameras. Altitudes flown are generally 25,000 to 35,000 feet. Sounds fantastic, doesn't it?—but this is modern warfare and photography is not only keeping pace, but in some cases is miles ahead.

The increasing widespread war uses of photography by foreign nations has not passed unnoticed by the Navy Department. Provision is being made for obtaining aerial photographs under all anticipated and probable conditions by providing adequate plane and material equipment.

An accelerated training program is providing expert, competent, trained personnel. An expanded organization has provided facilities for the efficient interpretation and use of all phases of ground and aerial photography in order to gain full advantage from this new weapon, without which no modern war can be prosecuted to a full and successful conclusion.

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(Continued from page 75)

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Finally, physical stamina and ruggedness are necessary for the accurate completion of all missions in order that fatigue may not dull the perceptions. This is especially true when it is remembered that physical relaxation is impossible in these small airplanes of long range and endurance. Also, expert navigation requires a clear head and smooth reactions throughout the flight, whether it be by day or by night, good weather or bad.

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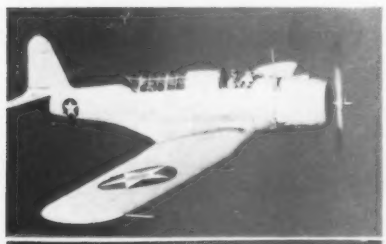

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The Coast Guard

(*Continued from page 127*)

U.S.S. Aphrodite, commanded by a Coast Guard officer, the late Rear Adm. F. C. Billard, who then had the rank of Captain. This vessel, while passing through the North Sea, struck a German mine, and the fact that she escaped serious damage and was able to proceed to Germany is probably unique in the history of vessels that have had mines explode under them.

During the war the management of the handling and loading of vast quantities of explosives in the harbor of New York, Philadelphia and Norfolk was largely entrusted to officers and men of the Coast Guard and the efficiency of that supervision is attested by the fact that not a single disastrous explosion occurred afloat in connection with this work. The port of New York made a record in the handling of explosives which is probably unique in the history of the world. Those who were not in close touch with the situation did not realize the difficulties, the delicacy of the task, and could not appreciate the many obstacles that had to be overcome in order that that great port should be thoroughly safeguarded. During the period from December 13, 1917, to the end of the fiscal year June 30, 1919, there was supervised at New York by officers and men of the Coast Guard the handling of high explosives in bulk, shells loaded with high explosives, smokeless powder, dynamite, ammunition, etc., aggregating 345,602 tons. In all, 1,698 vessels were loaded in effecting this movement. Every step of the handling was supervised by the office of the Captain of the Port, Capt. G. L. Carden, U. S. Coast Guard. The total value of the explosives carried on the 1,698 vessels was approximately $548,000,000. No accident occurred and not one life was lost.

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(*Continued on page 257*)

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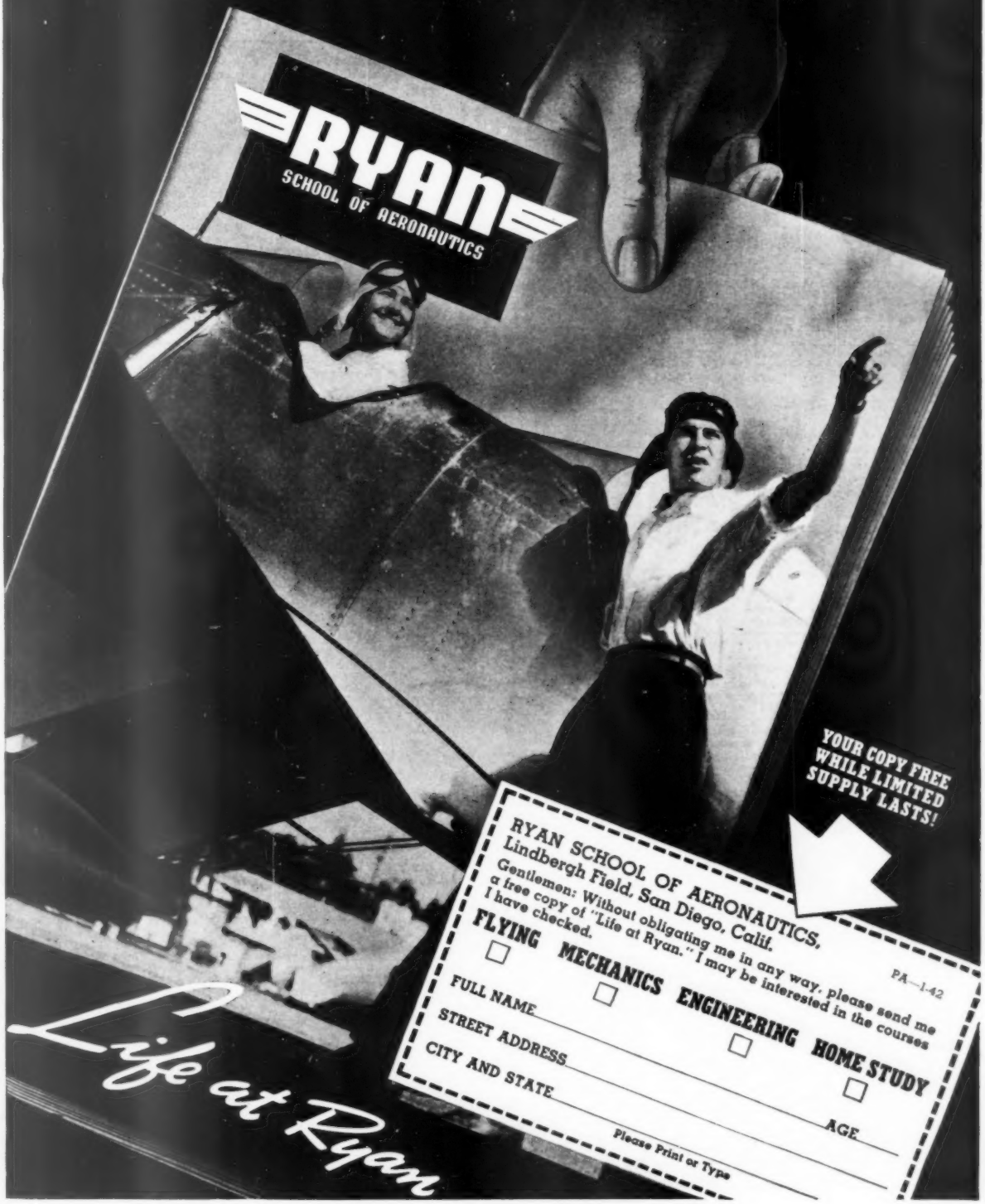

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The Coast Guard

(*Continued from page 254*)

outlying observation points along the coasts, involving as it did numerous engineering problems and careful supervision, was ably conducted by the personnel of the Coast Guard. The Coast Guard were suitably armed to repel any attempted landing from an enemy craft.

The activities of the Coast Guard Academy at New London, Conn., where the line and engineer officers of the Coast Guard are educated for the Service, were greatly increased during the war. In addition to the cadet course, a system of training for recruits enlisted in the Coast Guard was established there. Commodious barracks were erected and facilities were provided for the training of 500 enlisted men. Hundreds of recruits were given intensive training at the Academy and sent to cutters and to other units of the Coast Guard. The *Onondaga*, not fit for general service, was assigned to the Academy as a training ship and made short cruises along the coast with the recruits. On account of the facilities for training available there, recruits sent to ships from the Coast Guard training station were as well trained in practical seamanship work as those from any other training station in the country. The cadets were utilized in the training work with great advantage to themselves in the development of that important requisite in an officer, the ability to handle and drill enlisted men.

The incidents that have been recorded herein of the work of the Coast Guard in the World War are illustrations of the manner in which its officers and men performed the varied duties that fell to them to do. The motto of the Coast Guard is *Semper Paratus*. Throughout the time of their service as a part of the Navy, which extended from the day war was declared until August 28, 1919, when, under an executive order of the President they were returned to the jurisdiction of the Treasury Department, each officer and man of the Coast Guard was found always ready for any duty or responsibility that might be laid upon him.

Once again the Coast Guard is operating with the Navy. Only time will tell what future stories may be recorded of this fighting adjunct of the United States Fleet in the present emergency.

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Subscribe to Flying. See Page 174

To Identify Naval Aircraft

ONE of the simplest, yet efficient systems of identification has been perfected and adopted by the Navy Department's Bureau of Aeronautics. Once established in the mind, the system makes it possible to completely identify a Naval aircraft as to its mission, model number, manufacturer and modification number, simply by having that plane's identification designation.

All heavier-than-air craft come under the primary letter "V"; all lighter-than-air craft come under the letter "Z." This follows the system in the rest of the Navy: CV for aircraft carriers, BB for battleships, AV for aircraft tenders and so on. When referring to individual aircraft, however, the "V" is dropped for convenience.

The various missions coded for aircraft are as follows:

VF	Fighting	VB	Bombing
VSB	Scout-Bombing	VS	Scouting
VTB	Torpedo-Bombing	VT	Torpedo
VPB	Patrol-Bombing	VP	Patrol
VO	Observation	VOS	Observation-Scout
VSO	Scout-Observation	VJ	Utility
VJR	Utility-Transport	VR	Multi-engined transport
VG	Single-engine transport	VN	Training
VSN	Scout-Training	VM	Miscellaneous
		VL	Glider

Aircraft manufacturers are assigned letters, each of which must be part of any aircraft's designation thereafter. Manufacturer identifications are as follows:

A	Brewster	N	Naval Aircraft Factory
B	Boeing, Beechcraft	O	Lockheed
C	Curtiss	P	Spartan
D	Douglas	Q	Unassigned
E	Bellanca	R	Ryan
F	Grumman	S	Sikorsky, Stearman, Stinson
G	Unassigned	T	El Segundo (Douglas)
H	Unassigned	U	Vought-Sikorsky
J	North American	W	Waco
K	Fairchild	X	Experimental
L	Bell	Y	Consolidated
M	Martin		

By combining the above tables, and adding numbers for models and modifications, the system is completed. Martin, for example, produced a patrol bomber which turned out to be the first airplane in that category purchased by the Navy. Consulting the above tables, that airplane automatically became the Martin PBM; because it is the first modification of the type, the Navy calls it PBM-1. The next modification is the PBM-2, and so on. But Martin recently built its second patrol bomber design, so its designation automatically became PB2M-1 (the experimental model is called XPB2M-1).

The same system applies to all Naval aircraft. The F2A-2 becomes the second major design by Brewster, modification No. 2, Consolidated's *Catalina* is the PBY-5—Consolidated's first patrol bomber design, modification five. Now you see if you can work out a few: F4B-4, SB2U-3, NR-2, TB12W-16, SNJ-4, XF5F-2, SB2C-4.

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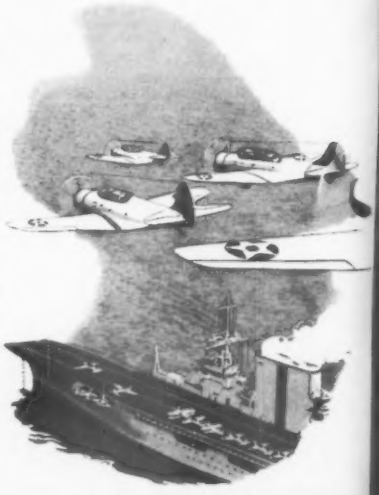

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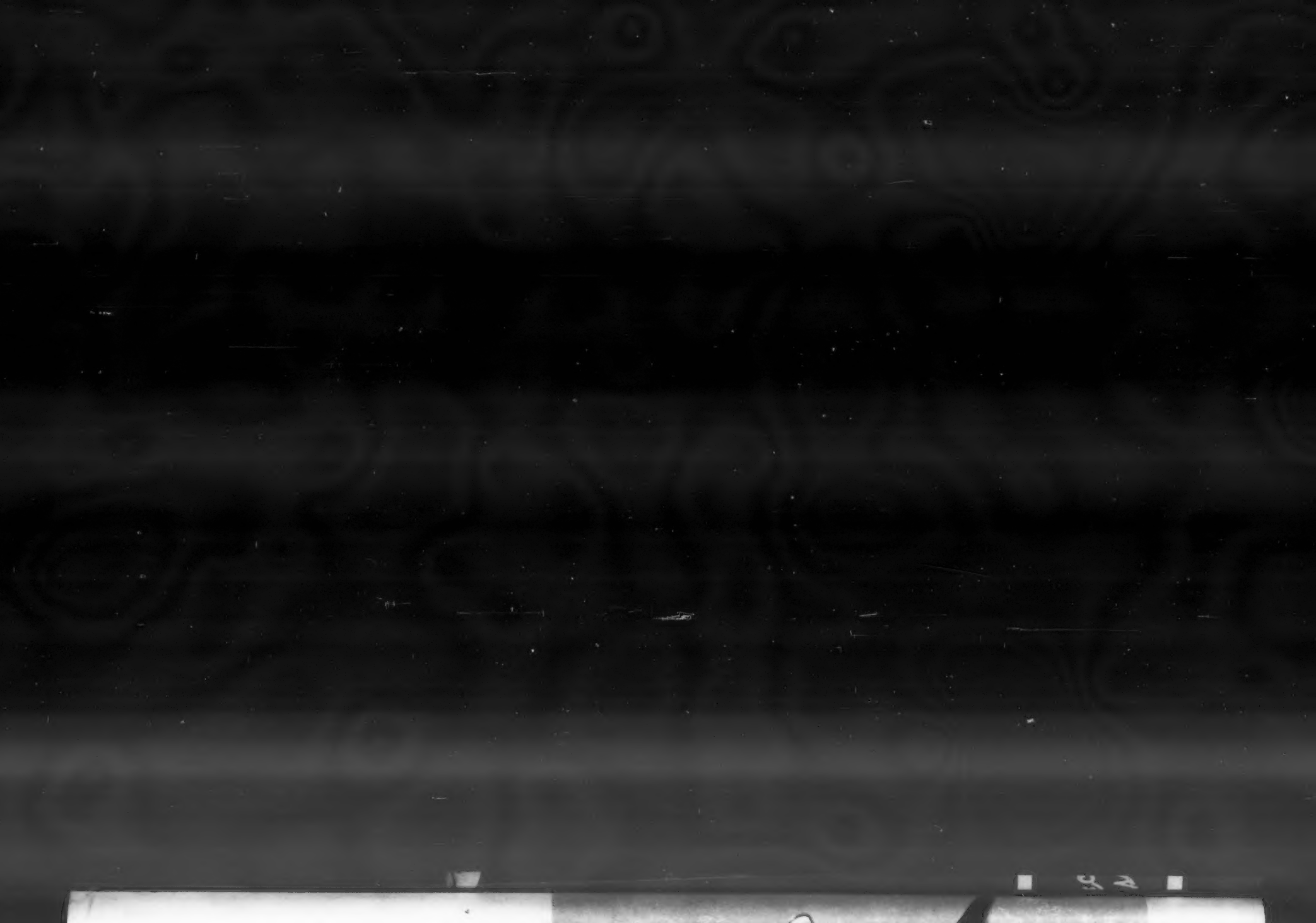
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